GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

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Date: October 8, 1976

Project Title: "Develop the Electromechanical and Memory Systems for a Personal Weighing Scale Product."

Project No: A-1899

Project Director: J. F. Lowry

Sponsor: Watson Brick and Tile Company, Tyler, Texas

Agreement Period: From September 7, 1976 Until open-ended

Type Agreement: Standard Industrial Research Agreement, dated September 7, 1976

Amount: Not to exceed $3,000/monthly.

Reports Required: Monthly Reports

Sponsor Contact Person (s):

Technical Matters

Contractual Matters
(thru OCA)

Mr. Russel B. Watson, Jr.
Watson Brick and Tile Company
P. O. Box 6483
Tyler, Texas 75701

Defense Priority Rating: N/A

Assigned to: Productivity/Technology Applications (School/Laboratory)

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CA–3 (3/76)

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OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: March 8, 1979

Project Title: Develop the Electromechanical and Memory Systems for a Personal Weighing Scale Product

Project No: A-1899

Project Director: W. S. Bulpitt

Sponsor: Watson Brick and Tile Company

Effective Termination Date: 3/5/79

Clearance of Accounting Charges: all clear

Grant/Contract Closeout Actions Remaining:

X Final Invoice ~~and Closing Documents~~xxxx
_ Final Fiscal Report
_ Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other ______________________________

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CA-4 (1/79)

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

November 4, 1976

Watson Brick & Tile
3901 South S.W. Loop 323
Tyler, Texas 75701

Attn: Mr. Russel B. Watson, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1899 for period 7 September 1976 to 31 October 1976

Dear Mr. Watson:

Attached you will find a report on our activities up to the present date. The report consists of three sections:

Section I - Comments on Patentability

Section 2 - The design logic of the scale, including search of cost compatible commercial items

Section 3 - Requirements for design completion

In the near future we are going to get a lawyer's opinion of the patentability of the item. While this is being done we will be in the process of building a prototype of the electronic circuit. When I receive the lawyer's response, I will get in touch with you to talk about future steps and, hopefully, to demonstrate a first prototype.

Respectfully submitted,

[redacted]

Pini H. Har-Oz [redacted]
Project Director

PHH:s
Enclosure

[redacted]

R. E. Yobs
Laboratory Director

Section I

COMMENTS ON PATENTABILITY, DIGITAL SCALE DEVICE

PROJECT A-1899

Consumer Description

A consumer description of the device may read as follows:

"The WEIGHT WATCHER is a 10" by 15" weight measuring device with the consumer in mind. It gives the weight in large, easy-to-read numerals like those found on digital calculators and such. With the touch of a toe on "your" button (one of four) the WEIGHT WATCHER tells you your previous weight plus or minus the difference. The four buttons are so each member of the family may keep up with his or her weight gain or loss. The scales would still give accurate readings to anyone using them. Very light weight and sleek in its design, the WEIGHT WATCHER would sell for under $50."

A schematic diagram of the device is shown in attachment 1.

Engineering Design

Progress on engineering design to date is shown in Attachment 2.

Patent Search

The U. S. Patent Office has designated Class 177 as weighers and weighing devices. This class is divided into several hundred sub-classes. None of these sub-classes is designated as digital weighing devices as such, although there are numerous patents on various digitizing schemes under a number of sub-classes. In the early 1970's the Patent Office began to use "digest numbers" to act as cross-references for newly developed categories of inventions. Under Class 177 Digest #3 is listed as electronic digitizing. A search of patents in Class 177 referenced under Digest 3 from 1971 until 1975 resulted in a large number of patents which involved analog digital conversion, digital to analog conversion, angle to digital conversion, and numerous methods for performing computations using the original digitized weight measured. These devices were listed in a variety of different sub-classes.

Two patents were for devices whose appearance and function is <u>similar</u> to the device in question. They are Patent #3, 797, 596 and #3, 838, 744. Both patents as seen in Attachment 3 are similar in appearance to operation of the device in question except:

1. Only the weight itself is displayed and there is no provision for showing weight changes.
2. There is no provision for storing and later recalling past weights of multiple individuals.
3. Neither of the devices previously patented (nor any of the other patents reviewed to date) digitize current weight using a linear motion-to-digital conversion scheme.

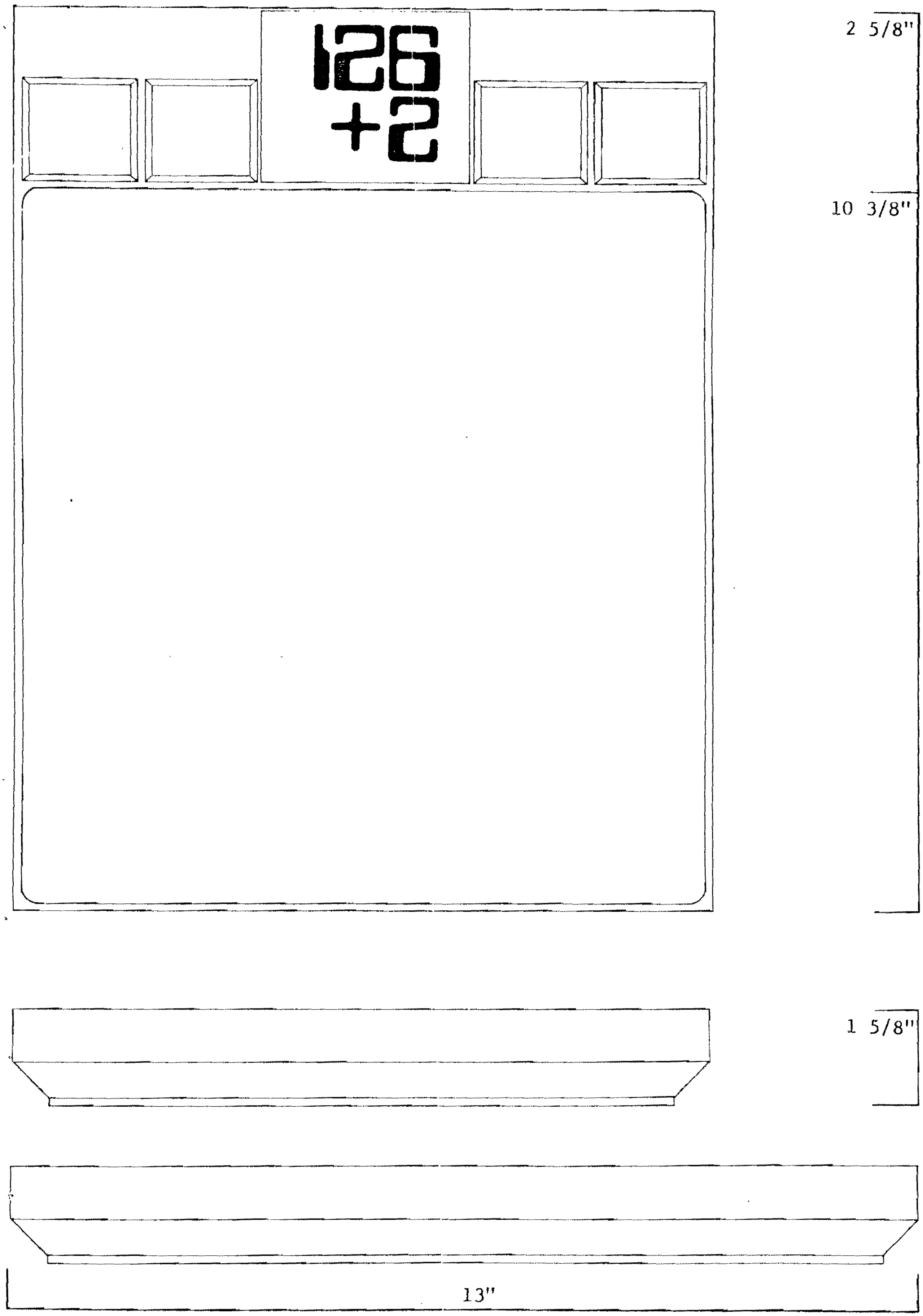
It is the belief of this writer that a patent may be obtained:

1. For the particular configuration of electronic and mechanical devices which result in the scale being designed or
2. The specific way in which weight is converted to digital form for this purpose or
3. Both of the above.

The Library offers a service to provide a complete search of:

1. A sub-class or
2. an entire class.

It is this writer's opinion at present that an entire class of patents would have to be searched in order to determine patentability. In the interest of time and money spent, however, this writer believes the most cost effective approach is to forward this document to a patent attorney, to give him a chance to review the document, and to meet with him in order to resolve these questions.


126
+2
2 5/8"
10 3/8"
1 5/8"
13"

United States Patent [19]

Tanji et al.

[11] **3,797,596**

[45] **Mar. 19, 1974**

[54] **DIGITAL DISPLAY BODY-WEIGHT METER**

[75] Inventors: **Mikiharu Tanji**, Watarai-gun; **Masanori Yamagiwa**, Ise City, both of Japan

[73] Assignee: **Ise Electronics Corporation**, Ise, Mie Prefecture, Japan

[22] Filed: **June 28, 1973**

[21] Appl. No.: **374,334**

[30] **Foreign Application Priority Data**

June 30, 1972	Japan	47-77463[U]
June 30, 1972	Japan	47-77464[U]
June 30, 1972	Japan	47-77465[U]
June 30, 1972	Japan	47-77466[U]
June 30, 1972	Japan	47-77467[U]
June 30, 1972	Japan	47-77470[U]

[52] **U.S. Cl.** **177/210,** 177/DIG. 3

[51] **Int. Cl.** **G01g 3/14**

[58] **Field of Search** .... 177/210, DIG. 1, DIG. 3

[56] **References Cited**

UNITED STATES PATENTS

2,961,647	11/1960	Dzaack	177/DIG. 3
3,203,495	8/1965	Lindberg et al	177/DIG. 3

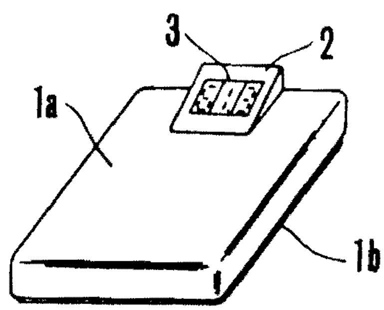
Primary Examiner—George H. Miller, Jr.

Attorney, Agent, or Firm—Chittick, Thompson & Pfund

[57] **ABSTRACT**

A digital display body-weight meter includes a positioning means to bring a code disc having a logic code arrangement to standstill at the termination of its rotation according to the descent of a footstool such that a detecting means to detect a logic code is located at the center of one of a plurality of logic codes, whereby reliable measurement signal may be obtained from the detecting means. It also includes means to bring the detecting means into contact with the logic code arrangement on the code disc after the termination of the rotation of the disc, whereby wear of brush and conductor can be eliminated and also good contact therebetween and reliable read-out of signal may be ensured.

7 Claims, 12 Drawing Figures



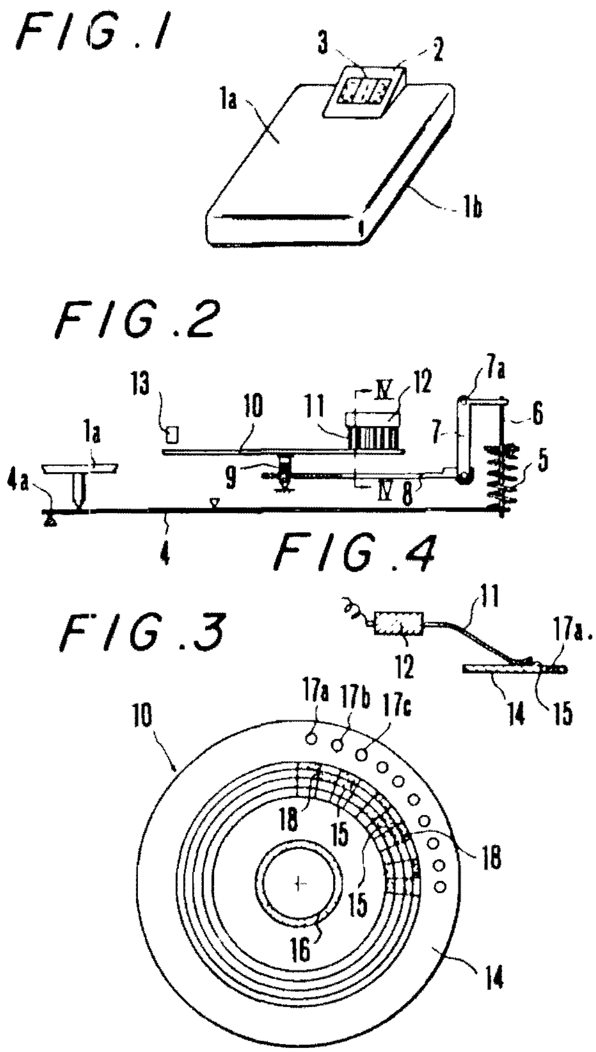


FIG. 1
3
2
1a
1b
FIG. 2
13
10
11
12
7a
6
7
5
1a
4a
9
8
4
FIG. 4
11
17a.
12
14
15
FIG. 3
17a
17b
17c
10
18
15
18
15
16
14

FIG. 5

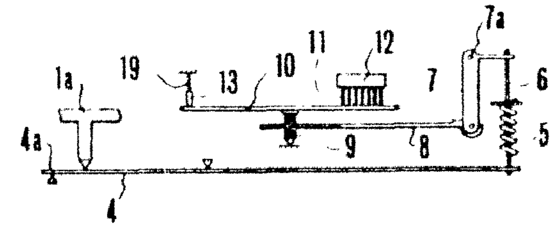


FIG. 6

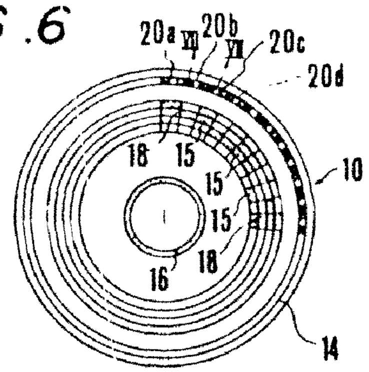


FIG. 7

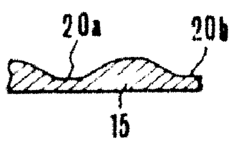


FIG. 8

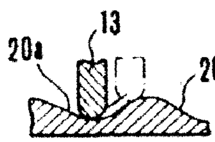


FIG. 9

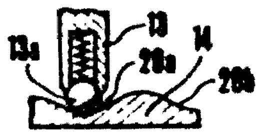


FIG. 10

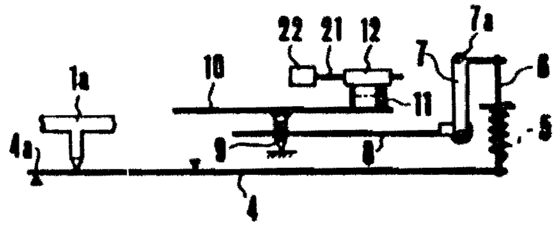


FIG. 11

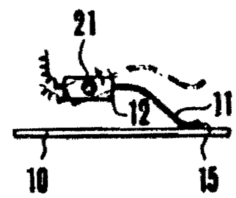
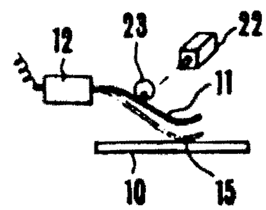


FIG. 12



3797596

DIGITAL DISPLAY BODY-WEIGHT METER

BACKGROUND OF THE INVENTION

This invention relates to body-weight meters and, more particularly, to a digital display body-weight meter using a code disc rotated in proportion to the body weight being measured.

In the prior-art body-weight meter of this type, the amount of descent of a footstool that results when a person rides thereon is converted into a corresponding extent of rotation of the code disc, and a corresponding code is detected by brush means as an electrical signal, which is digitally displayed on a numeral display tube.

In the body-weight meter of this type, however, the brush means is always urged against the code disc, that is, it is in frictional contact with the disc when the disc is rotating. Therefore, the brush and the conductor on the code disc are subject to wear, and also contact failure is likely to result. Further, the greater the load due to wear, the greater the corresponding error.

In a further aspect, if the brush means is positioned on a borderline between adjacent conductor logics of the code at the termination of the rotation of the disc, the signal read out from the brush is unreliable and prone to error, resulting in the display of an erroneous measurement.

SUMMARY OF THE INVENTION

An object of the present invention, accordingly, is to provide a body-weight meter, which is free from wear of brush means and conductor on the code disc and contact failure between them at the time of the measurement.

Another object of the invention is to provide a body-weight meter, which ensures reliable measurement signal to be read out from the brush.

The invention features a digital display body-weight meter, which comprises a footstool, a code disc having a circumferential arrangement of a plurality of electrical conductor logic codes and adapted to be rotated according to the extent of descent of a footstool that results when a body to be measured rides thereon, a detecting means to detect an electrial conductor logic code corresponding to the descent of the footstool, a means to bring the detecting means into contact with the conductor code arrangement on the code disc after the termination of the rotation of the disc, and a display section for digitally displaying the output of the detecting means.

The invention also features a digital display body-weight meter, which further comprises means to bring the code disc to standstill at the termination of its rotation such that the detecting means does not stride between adjacent conductor codes but does face only one conductor code.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the invention will become more apparent from the following description when the same is read in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a typical digital display body-weight meter;

FIG. 2 is a fragmentary side view showing the inside mechanism of a digital display body-weight meter embodying the invention;

FIG. 3 is a plan view, to an enlarged scale, showing the code disc in the embodiment of FIG. 2;

FIG. 4 is a fragmentary sectional view taken along line II — II in FIG. 2;

FIG. 5 is a view similar to FIG. 2 but showing a different embodiment of the invention;

FIG. 6 is a plan view, to an enlarged scale, showing the code disc in the embodiment of FIG. 4;

FIG. 7 is a sectional view, to an enlarged scale, taken along line V — V in FIG. 5;

FIG. 8 shows the state of the engagement of a positioning member in a recess in the code disc;

FIG. 9 is a view similar to FIG. 7 but showing a modified positioning member;

FIG. 10 is a fragmentary side view showing a further embodiment of the invention;

FIG. 11 is a fragmentary view, to an enlarged scale, showing the operation of the brush support; and

FIG. 12 is a view similar to FIG. 10 but showing a modification of the arrangement of FIG. 10.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a typical digital display body-weight meter. Reference symbols 1a and 1b respectively designate a footstool and a base frame, and numeral 2 designates a display section having a numerical display tube 3.

In this meter, the extent of descent of the foot-stool 1a due to a body-weight thereon is converted through an electric converting mechanism into a corresponding electric signal, from which the weight is displayed on the numerical display tube 3 on the digital display section 2.

FIG. 2 shows a side view of the essential inside mechanism of a digital display body-weight meter embodying the invention. In the Figure, reference numeral 4 designates a lever pivotable about a fulcrum 4a, numeral 5 a spring, numeral 6 a pin, numeral 7 a bell-crank pivoted at 7a, numeral 8 a rack linked at one end to the bellcrank 7, numeral 9 a pinion meshing with the rack 8, numeral 10 a code disc secured to the pinion 9, numeral 11 a plurality of code detection brushes for detecting a particular code on the code disc, numeral 12 a brush support supporting the brushes 11, and numeral 13 a positioning member which is a permanent magnet.

FIG. 3 shows the code disc 10 in detail. It consists of a disc member 14 of an insulating material. The disc member 14 is provided on the upper side with a circumferential electrical conductor logic code arrangement 15 and a grounding conductor 16 concentric therewith. It is also provided with magnetic material pieces 17a, 17b, 17c, . . . , which are circumferentially spaced, each being located adjacent a corresponding conductor logic code of the arrangement 15 between adjacent borderlines 18.

The operation of the above construction will now be described. When a person rides on the footstool 1a of the body-weight meter, the footstool 1a is lowered due to his weight, causing the rotation of the lever 4 about the fulcrum point 4a in the clockwise direction in FIG. 2 against the spring force of the spring 5. The rotation of the lever 4 is transmitted through the pin 6 to the bellcrank 7, causing the rotation of the bellcrank 7 about the support pin 7a thereof in the clockwise direction, thus driving the rack 8 in the leftward direction. As a result, the code disc 10 is rotated through the pinion 9 to an extent corresponding to the weight borne by the footstool 1a.

At this time, if the code disc 10 is about to come to standstill with the brushes 11 positioned on a borderline 18 between adjacent logic codes, one of the magnetic material pieces 17a, 17b, 17c, . . . corresponding to either one of the afore-mentioned adjacent logic codes is attracted by the permanent magnet 13, so that the code disc 10 may be slightly rotated to position the brushes 11 on a central portion of either one of the adjacent logic codes. Thus, a reliable output signal can be taken out from the brushes 11. The signal thus derived is decoded and displayed on the numerical display tube 3, so that it is possible to obtain reliable digital display of the measurement of the weight.

While in the preceding embodiment a single permanent magnet has been used, it is of course possible to provide a plurality of permanent magnets in the same positional relation. Further, it is possible to provide a plurality of permanent magnets in place of the magnetic material pieces while providing a magnetic material piece in place of the permanent magnet. Furthermore, it is of course possible to replace the permanent magnet with an electromagnet.

Moreover, the brushes used in the preceding embodiment for reading out the logic code on the code disc is by no means limitative, but any other suitable logic code detecting means may be employed as well.

FIG. 5 shows a second embodiment of the invention. In the Figure, numerals 4 to 12 designate the same parts as those of like numerals in FIG. 2. Numeral 13 designates a positioning member downwardly biased by a spring 19.

FIG. 6 shows the code disc 10 of this embodiment in detail. It consists of a disc member 14 of an insulating material. The disc member 14 is provided on the upper side with a circumferential electrical conductor logic code arrangement 15 and a grounding conductor 16 concentric therewith. It is also provided with recesses 20a, 20b, 20c, . . . , which are circumferentially spaced, each being located adjacent a corresponding conductor logic code in the logic code arrangement 15 between adjacent borderlines 18.

FIG. 7 shows a sectional profile of a typical recess 20a.

The operation of this embodiment is similar to that of the preceding embodiment. In this embodiment, however, if the code disc 10 is about to come to standstill with the brushes 11 at a position on a borderline 18 between adjacent logic codes, the positioning member 13 is caused to slip along one inclined surface of one of the recesses 20a, 20b, 20c, . . . corresponding to either one of the aforementioned adjacent logic codes as shown in FIG. 8, so that the code disc 10 may be slightly rotated to position the brushes 11 on a central portion of either one of the adjacent logic codes. Thus, a reliable output signal can be taken out from the brushes 11. The signal thus taken out is decoded and displayed on the numerical display tube 3, so that it is possible to obtain reliable digital display of the measurement of the weight.

While in the above embodiment a single positioning member has been used, it is of course possible to provide a plurality of positioning members in the same positional relation. Also, the brushes used for reading out the logic on the code disc is again by no means limitative, but any other suitable logic detecting means may be used as well.

FIG. 9 shows a modification of the positioning member in the preceding embodiment. This modified positioning member 13 is provided at its free end with a ball 13a. The ball 13a can roll on the inclined surface of the recesses 20a, 20b, 20c, . . . , so that smoother positioning of the code disc 10, that is, the positioning of a logic conductor code with respect to the brushes, may be ensured.

In the preceding embodiments, the brushes are always urged against the code disc. This means that the brushes and the conductor on the code disc are subject to wear and that contact failure is likely to result as has been mentioned earlier.

FIG. 10 shows a modification of the previous embodiment of FIG. 2 or 5. In the Figure, the same reference numerals as those in FIG. 2 or 5 designate like parts. Also, although not shown in the Figure, a positioning means such as the permanent magnet 13 in the embodiment of FIG. 2 or the positioning member 13 biased with the spring 19 in the embodiment of FIG. 5 may be provided. In this embodiment, the brush support 12 is rotatably supported on a shaft 21, which is driven by a rotary solenoid 22 converting a linear attraction of an electromagnet into the rotation of the shaft 21 by a fixed angle. The rotaty solenoid 22 is energized a predetermined delay time after the closure of a switch not shown upon the descent of the footstool or upon detection of the stoppage of the rotation of the code disc through a tachogenerator.

When the rotaty solenoid 22 is energized, the shaft 21 is rotated, causing the rotation of the brush support 12 from the position of dashed line to the position of solid line in FIG. 11. As a result, the brushes 11 are forced into contact with the conductor on the code disc 10 to detect the logic code as electric signal. The electric signal thus derived is decoded and displayed on the numerical display tube.

It will be seen that in this embodiment the brushes are brought into contact with the conductor after the code disc is stopped, so that wear of the brushes and conductor can be eliminated and good contact and reliable read-out may be ensured.

FIG. 12 shows a modification of the preceding embodiment. In this modification, the brush support 12 is fixed in position, and the brushes 11 are adapted to be urged against the code disc 10 by a cam 23, which is driven by a rotary solenoid 22 converting a linear attraction of an electromagnet into the rotation of the cam 23 by a fixed angle. The rotary solenoid 22 is energized a predetermined delay time after the closure of a switch not shown upon the descent of the footstool or upon detection of the stoppage of the rotation of the code disc through a tachogenerator.

When the rotary solenoid 22 is energized, the cam 23 is rotated to cause the displacement of the brushes 11 from the position of solid line to the position of dashed line into contact with the conductor on the code disc 10 for the detection of the logic code as electric signal.

Thus, the same effects as in the preceding embodiment may be obtained. In addition, leads leading from the brushes will not be subject to any bending stress, so that their service life may be extended.

As has been described in the foregoing, with the digital display body-weight meter according to the invention reliable positioning of a logic code on the code disc with respect to the brushes may be ensured to obtain reliable measurement signal from the brushes. Also, since the brushes are brought into contact with the conductor after the stoppage of the code disc, wear of the brushes and the conductor can be eliminated and also good contact and reliable read-out of the signal may be ensured.

What is claimed is:

1. A digital display body-weight meter comprising a footstool, a code disc having a circumferential logi code arrangement of a plurality of electrical conductor codes and adapted to be rotated according to the extent of descent of said footstool that results when a body to be measured rides thereon, a detecting means to detect at least one electrical conductor code corresponding to the descent of the footstool, a positioning means to bring the code disc to standstill at the termination of its rotation such that said detecting means is located at the center of one of said electrical conductor codes, and a display section for digitally displaying the output of said detecting means.

2. A digital display body-weight meter according to claim 1, wherein said code disc also has a grounding conductor concentric with said logic code arrangement.

3. A digital display body-weight meter according to claim 1, wherein said detecting means comprises at least one brush capable of being brought into contact with said electrical conductor codes, a rotatable brush support supporting one end of said brush and a rotary solenoid means co-operating with a rotative shaft of said brush support, said brush being brought into contact with said electrical conductor codes only when said rotary solenoid means is energized.

4. A digital display body-weight meter according to claim 1, wherein said detecting means comprises at least one brush capable of being brought into contact with said electrical conductor codes, a brush support supporting one end of said brush, a cam member rotatable and capable of urging said brush and a rotary solenoid means co-operating with said cam member, said brush being urged by said cam member into contact with said electrical conductor codes only when said rotary solenoid means is energized.

5. A digital display body-weight meter according to claim 1, wherein said positioning means comprises a plurality of magnetic material spaced along the circumference of said code disc and individually located adjacent respective conductor codes between adjacent borderlines between adjacent conductor codes and at least one magnet held at a fixed position and capable of facing said magnetic material pieces.

6. A digital display body-weight meter according to claim 1, wherein said positioning means comprises a plurality of recesses individually formed in said code disc adjacent respective conductor codes between adjacent borderlines between adjacent conductor codes and at least one positioning member capable of facing said recesses and adapted to be urged into engagement in said recesses.

7. A digital display body-weight meter according to claim 6, wherein said at least one positioning member is provided with a rolling member capable of being in rolling contact with said recesses.

* * * * * *

United States Patent [19]

Tanji et al.

[11] **3,838,744**

[45] **Oct. 1, 1974**

[54] **BODY WEIGHT MEASURING DEVICE**

[75] Inventors: **Mikiharu Tanji**, Watarai; **Masanori Yamagiwa**, Ise City, both of Japan

[73] Assignee: **ISE Electronics Corporation**, Ise City, Mie Prefecture, Japan

[22] Filed: **June 28, 1973**

[21] Appl. No.: **374,333**

[30] **Foreign Application Priority Data**

June 30, 1972 Japan 47-77468

[52] **U.S. Cl.** **177/177**, 177/210, 177/DIG. 3

[51] **Int. Cl.** **G01g 23/30**, G01g 3/14

[58] **Field of Search** .... 177/177, 210, DIG. 3

[56] **References Cited**

UNITED STATES PATENTS

3,163,247	12/1964	Bell et al.	177/DIG. 3
3,381,767	5/1968	Rasrigh	177/210 X

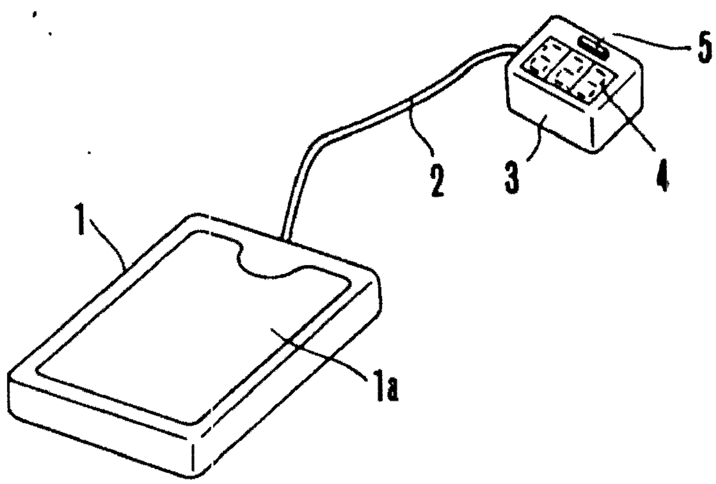
Primary Examiner—George H. Miller, Jr.

Attorney, Agent, or Firm—Dike, Bronstein, Roberts, Cushman & Pfund

[57] **ABSTRACT**

In a body weight measuring device of the type wherein the body weight is displayed by digital display tubes, the display tubes and a source switch are combined into a display unit which is connected to the weight measuring device through an electric cable.

3 Claims, 6 Drawing Figures



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PATENTED OCT 1 1974 3,838,744

FIG. 1

FIG. 2

FIG. 3

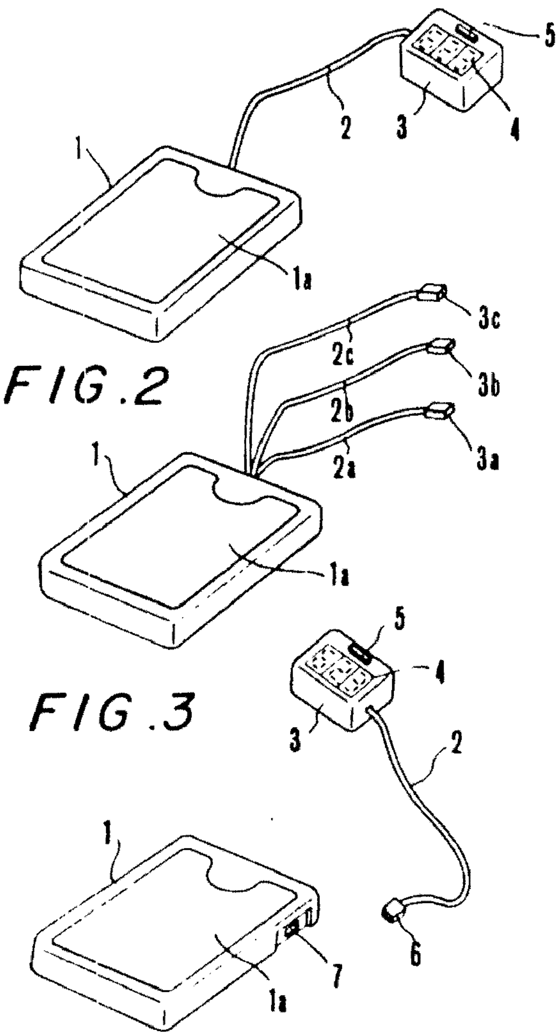

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FIG. 4

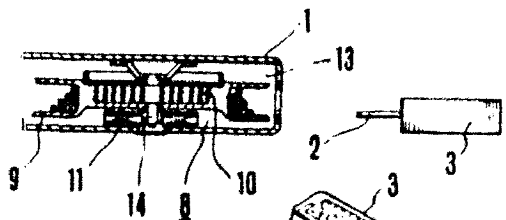


FIG. 5

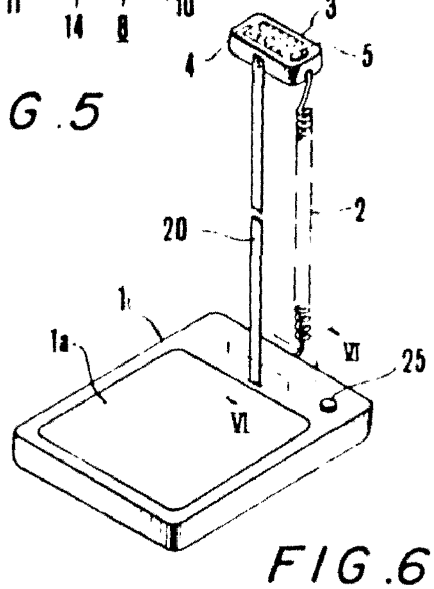
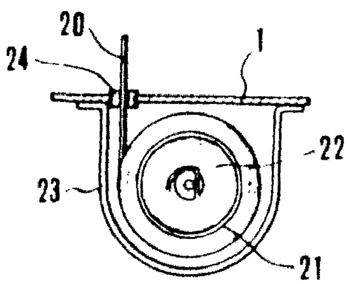


FIG. 6



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BODY WEIGHT MEASURING DEVICE

BACKGROUND OF THE INVENTION

This invention relates to a body weight measuring device of the type wherein the weight of a human body is displayed on a digital display means.

In the prior art, a body weight measuring device of the type referred to above, comprises a platform adapted to support a human body to be weighed, a converter positioned beneath said platform for converting the downward movement of the platform which is caused by the weight of the human body into an electrical signal, a display unit including a plurality of digit display tubes for providing visual display of the numerical value of the weight of the human body, and a source switch for connecting the converter and the display unit across a source of supply. The display unit is mounted on the platform just in the same manner as a scale and a pointer which is rotated along the scale in response to the downward movement of the platform. The source switch is also mounted on or near the platform. For this reason, it is difficult for a man standing on the platform to read the displayed digits and he must bow his body to operate the source switch. Moreover, it has been necessary to maintain the source switch in its closed position for a relatively long period because it takes a certain time for the platform to reach a stable condition after a person to be weighed is supported thereon. Furthermore, with the prior art weighing device it has been difficult to digitally display the weighed weight at a plurality of discrete locations.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide a new and improved body weight measuring device capable of providing a readily visible digital display of the weight.

Another object of this invention is to provide an improved body weight measuring device including a source switch which can be operated readily only when the display of the weighed weight is to be made.

Still another object of this invention is to provide a body weight measuring device including a digital display unit and a source switch which can be supported at any desired height above the platform suitable for reading and manipulation.

A further object of this invention is to provide an improved body weight measuring device capable of digitally displaying the weighed weight at a plurality of locations remote from the platform.

According to a broad aspect of this invention these and further objects can be accomplished by providing a body weight measuring device of the type comprising a base, a platform resiliently mounted on the base, said platform displacing downwardly when a body being weighed is supported thereon, means for converting the downward movement of the platform into an electric signal, a display tube connected to display the electric signal and a source switch for controlling the connection between a source of supply and the converting means and the display tube, characterized in that the display tube and the source switch are combined into a display unit and that the display unit is connected to the converting means through an electric cable outside of the base.

With this improved construction, the body weight of a person can be readily read on the display tube while he holds the display unit in his hand or by mounting the display unit on a nearby wall at a height of the eyes. Further, he can readily operate the weighing device by manipulating the source switch incorporated into the display unit.

The cable may be connected to the base through cooperating plug and socket or housed in the base by means of a retriever. If desired, a plurality of independent display units may be connected to the base through discrete cables in order to enable to indicate body weight at different locations.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a diagrammatic perspective view of one embodiment of this invention;

FIG. 2 shows a similar view of a modification wherein a plurality of display units are used;

FIG. 3 is a perspective view of another modification wherein cooperating plug and socket are used for connecting the display unit to the base;

FIG. 4 shows a sectional view of a portion of the base containing a retriever for a display unit,

FIG. 5 is a perspective view of yet another embodiment of this invention and

FIG. 6 is a sectional view of a portion of the base taken along a line VI—VI shown in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of this invention shown in FIG. 1 comprises a platform 1*a* adapted to support a human body to be weighed. As in the conventional weighing device, the platform 1*a* is resiliently supported on a base 1 by means of spring means, not shown, so that platform 1*a* moves downwardly a little when a body to be weighed is supported thereon. A suitable converter, not shown, is provided beneath the platform so as to convert this downward displacement of the platform into an electrical signal.

According to this invention, a display unit 3 including a plurality of digit display tubes 4 is connected to the converter through an electric cable 2 having a suitable length so that the electric signal is decoded by a suitable decoder, not shown, for selectively operating the digit display tubes, thereby providing a visible digital display of the body weight. Furthermore, in accordance with this invention, a source switch 5, that is a switch for connecting the signal converter, decoder and display tubes 4 across a source of supply, not shown, is incorporated into the display unit 3.

In operation, a man whose body weight is to be measured steps on platform 1a while holding the display unit 3 in one hand. After the platform reaches a stable condition he closes the source switch 5 to digitally display his weight on digit display tubes 4. When the displayed digits are recorded, he opens the source switch and gets down.

In this manner, since the man himself holds the display unit in his hand he can readily read the displayed digits, and since the source switch is closed only when the displayed digits are to be read, it is possible to shorten the period of energization of the electric circuitry thereby reducing the power concerned thereby and increasing their lives.

Although in the foregoing description it was assumed that the man being weighed holds the display unit in his hand, in this case, the weight of the display unit will also be displayed. Although the error caused by the weight of the display unit is negligibly small, such error can be readily eliminated by providing a suitable compensating circuit for the signal converter for the purpose of subtracting the weight of the display unit from the weight measured by the platform. Alternatively, the display unit may be hung on a nearby wall at the level of the eyes.

FIG. **2** shows a modified embodiment of this invention in which a plurality of discrete display units *3a*, *3b* and *3c* are connected in parallel to the signal converter located beneath the platform **1***a* through discrete electric cables *2a*, *2b* and *2c*, and at least one of the display units is provided with a source switch. This modification is suitable for measuring the body weight of students in a school so as to permit each of the students, measurer and recorder to operate the source switch and to read the displayed digits.

FIG. **3** shows a perspective view of a further modification of this invention in which the electric cable **2** is detachably connected to base **1** by means of cooperating plug **6** and socket **7**. This modified construction permits one to independently put away the base and platform, and the cable and display unit.

FIG. **4** shows a section of a portion of a base **1** containing a cable retriever **8** which comprises a reel **9** adapted to take up cable **2** connected to display unit **3**, a spiral spring **10** interposed between reel **9** and a shaft **14**, a group of sliding contacts **11** between cable conductors and the circuits contained in the base. Although not shown in the drawing, it is to be understood that a suitable mechanism for applying and removing a braking force to and from the reel **9** is provided in the same manner as in the prior art cable retriever so that when the display unit **3** is released it can be automatically retrieved in the base. Thus, when the weighing device is not used, the cable **2** is contained in the base **1** so that it is easy to handle or transport the weighing device.

In another modification of this invention shown in FIGS. **5** and **6** a display unit **3** having the same construction as that shown in FIG. **1** is mounted on the upper end of a steel band **20** constructed to extend and contract in the vertical direction. The steel band has a curved cross section so that it does not bend away from the vertical position when it is pulled upwardly as shown in FIG. **5**. The inner end of the steel band is wound about a reel **21** which is biased to take up the steel band by the action of a spiral spring **22**. The coil of the steel band wrapped about reel **21** is housed in a housing **23**. A frictional bushing **24** is mounted in an opening of base **1** so as to prevent the steel band from being depressed downwardly or wound about reel **21** by the weight of the display unit **3**. With this construction, it is possible to support the display unit **3** at any desired height above the platform **1***a*.

If desired an adjusting knob **25** may be provided for base **1** for compensating the weight of suit worn by the human body to be weighed or an error of measurement. By mounting the display unit on the upper end of the steel band at an angle with respect to the horizontal the digits displayed can be more readily read.

What is claimed is:

1. In a body weight measuring device of the type comprising a base, a platform resiliently mounted on said base, said platform displacing downwardly when a body being weighed is supported thereon, means for converting the downward movement of said platform into an electric signal, a display tube connected to display said electric signal and a source switch for controlling the connection between a source of supply and said converting means and said display tube, the improvement wherein said display tube and said source switch are combined into a display unit and said display unit is connected to said converting means through an electric cable outside of said base and wherein an automatic retriever for taking up said cable is provided for said base.

2. In a body weight measuring device of the type comprising a base, a platform resiliently mounted on said base, said platform displacing downwardly when a body being weighed is supported thereon, means for converting the downward movement of said platform into an electric signal, a display tube connected to display said electric signal and a source switch for controlling the connection between a source of supply and said converting means and said display tube, the improvement wherein said display tube and said source switch are combined into a display unit and said display unit is connected to said converting means through an electric cable outside of said base and wherein said display unit is mounted on the top of a steel band which is mounted on said base to be extendable and contractable in the vertical direction.

3. The body weight measuring device according to claim **2** wherein the lower end of said steel band is connected to a reel which is spring biased to take up said steel band.

* * * * *

Section 2

DESIGN LOGIC

The study of the Weight Watcher Scales has progressed through several considerations and optimizations.

Various present manufactures of similar products were found, but the cost of such units ranges from $3,400 (Ormond, Inc.) to an $880 model made by Micro-Strain, Inc. These prices lie well outside the limits set upon our project so consideration of redesigning present models appears to be outside our possible solutions.

The major problem in design of a digital readout is the conversion of weight to digital information. There are two ways to derive the weight information; Load Cells and Encoders.

Load cells utilize the property that some materials possess, of giving a resistance change when they undergo compression or they may yield different voltages when they are put under strain. Load Cells are generally accurate to + 0.1 %, but their cost ranges from $450 for some strain gage types to $75 for variable resistance types. All Load Cells require an Analog to Digital Converter ($8) and some require amplification circuitry($5).

Encoders operate by the change in position of a disk or shaft relative to some contacts. Shaft encoders available on the market vary in cost from $250 to $95 and usually provide + 1% accuracy.

Disk encoders presently on the market are designed for high speed use which increases cost, but they are comparable in cost to the shaft encoders. Disk encoders would be the simplest to construct due to the design which consists of a coded surface and a set of brushes (contacts; one for each bit of information).

The encoder chosen for the Weight Watcher was thus the disk with the coded surface replacing the normal printed disk found in the present non-digital scales on the market.

With the encoder decided upon the next problem is what type of code to use on the disk. Three possibilities were considered:

(1) Straight Binary Output
(2) Seven Segment Code
(3) Binary Coded Decimal (BCD)

The straight binary has the advantage of being directly compatable with digital arithmetic operations which are required for the display of the difference in weight. The display we intend to use would be a seven segment Light Emitting Diode array which must have a Seven segment code to operate. There are BCD to Seven Segment converters available, but there are no Binary to Seven Segment Converters. Binary to BCD converters cost about $2 each and the BCD to Seven Segment converters are about $1 each. For optimization of cost a binary encoder and Binary to BCD and BCD to Seven Segment converters is the choice. If it is feasible, a BCD code may be incorporated so that actually two codes are on the encoder board, one driving the display of present weight and the other driving the addition circuitry for weight difference.

Two methods of computing the difference between previous and present weighings were studied:

(1) Calculator Chip
(2) Binary Adder Chip

The calculator is easily used to subtract data as it only requires selection of one input and the output is already coded for use with seven segment displays. However the data must be presented in a complex fashion utilizing a two phase clock system and serial entry. This means for our scales associated logic would require more consideration and precision.

The Binary Adder Chip requires no clocking circuitry and allows parallel entry of data. The adder costs about $1 while the calculator is between $3 and $7. Memory was considered along with the addition circuitry. To conserve battery power when between weighings a low power Random Access Memory was chosen over discrete latches. The cost of the discrete latches would be about twice the $5 RAM (2101: 256 x 4 bits). Other memories are available which require less power but their cost is considerably greater.

The cost of full parallel operation versus half-serial/half-parallel operation was next checked. The full parallel system requires more memory and more addition logic, while the combination method requires more timing but less memory. The cost comparison showed the half-serial/half-parallel to be optimum.

Binary adders come in 4 bit packages meaning each adder can handle up to four bits of data. Four bits can specify sixteen different possibilities. If the adder is used twice in our half serial operation eight bits can be added but twice the supporting circuitry is required. If used three times again there is an increase in support devices. Eight bits can specify two hundred fifty six possibilities; thus including zero, two hundred fifty five weights are possible. The increase of even one bit however increases costs again, and for this reason an eight bit system was decided upon.

After designing the clock and control circuitry the system was tested on a synthesizer. This device allows various integrated circuits to be connected and the design thus tested for logical or electrical faults. The synthesizer allows the display of the inputs and outputs as well as various control signals. The circuit was then optimized and retested through the use of certain reduction techniques(Karnough Map and Quine-M^{c}Clusky alogrithm).

The system is thus developed to the point that a description of its operation is possible.

1) A person may check the Zero by a switch that activates the readout which may be corrected as necessary.

2) One of four memory switches is selected to obtain previous data stored in the RAM.

3) The scale is then mounted, activating a power switch and through mechanical linkages and spring tension rotates the encoder on brushes.

4) After approximately four seconds (for the system to come to equilibrium) the weight appears and after the calculation the difference weight is displayed.

5) The display will remain active as long as weight is present.

6) Upon dismounting the scale the power switch and memory switch are returned to the off state.

If no memory switch is activated then only the weight is displayed without a difference weight.

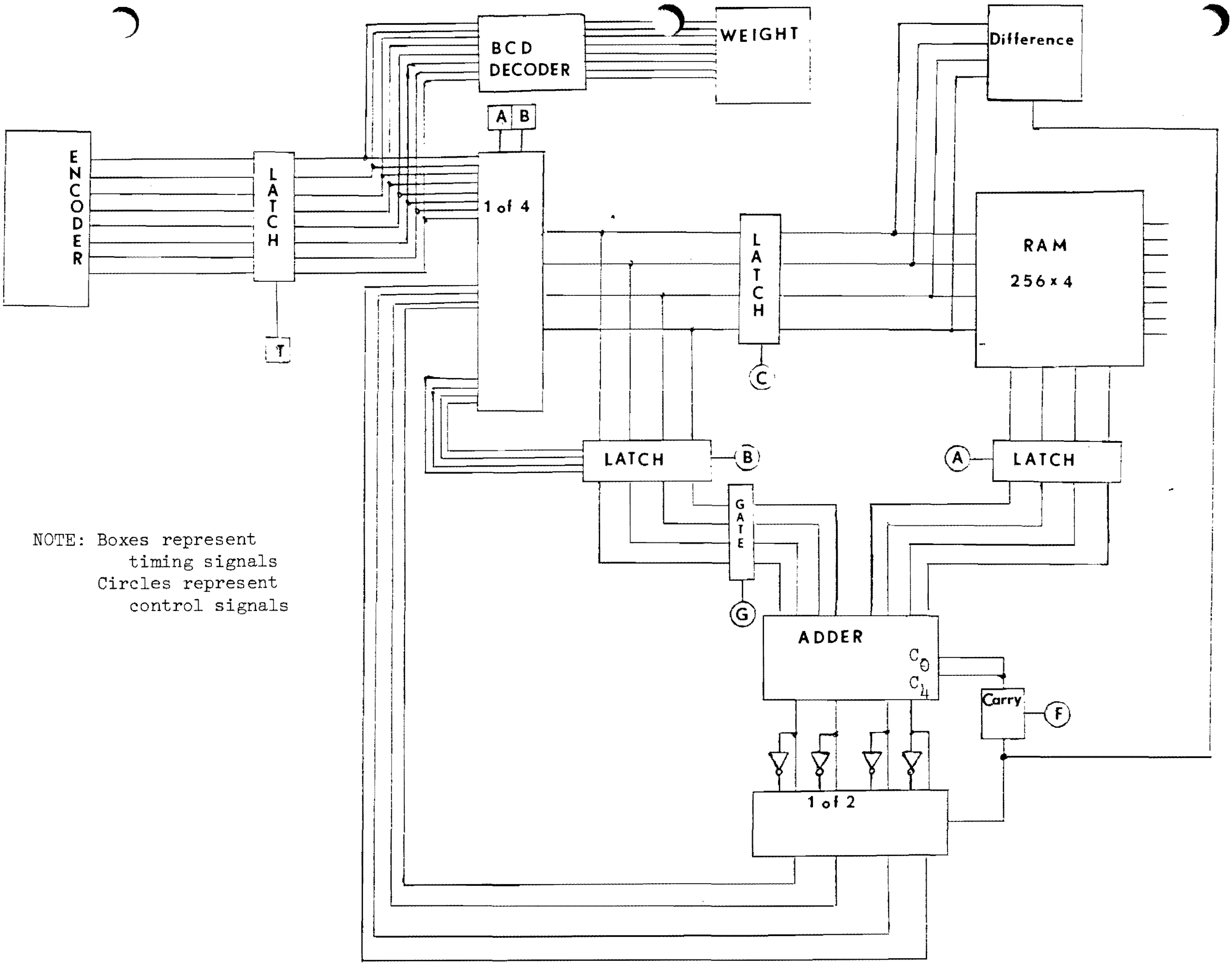
The folowing figures show the various design considerations and control and clocking circuitry.

1) Block diagram of Addition circuitry

2) System Timing Operations

3) Clock derivation

4) Control signal derivation



NOTE: Boxes represent timing signals
Circles represent control signals

FIGURE 1

Figure 2

SYSTEM TIMING OPERATIONS

1 of 4	D	C	B	A	CK		R/W	A	B	C	E	F	G
LSN	0	0	0	0	0 1	Load A and B registers with LSN	1	1 0	1 0	X	X	X	X
MSN	0	0	0	1	0 1		0	0	0	X	X	X	X
1 of 2	0	0	1	0	0 1	Store $\overline{\text{SUM}}$	1	0	0	1 0	1	1 0	1
$\overline{\text{B}}$	0	0	1	1	0 1	Load C with $\overline{\text{LSN}}$ from B	X	X	0	1 0	X	0	X
LSN	0	1	0	0	0 1	Write $\overline{\text{LSN}}$ from C into RAM	1	X	X	0	X	0	X
MSN	0	1	0	1	0 1	Load A and B with MSN	0	1 0	1 0	X	X	0	1
1 of 2	0	1	1	0	0 1	Save CARRY Bit	0	0	0	X	X	1 0	1
$\overline{\text{B}}$	0	1	1	1	0 1	Load C with $\overline{\text{MSN}}$	X	X	0	1 0	X	0	X
LSN	1	0	0	0	0 1		0	X	X	0	X	0	X
MSN	1	0	0	1	0 1	Load $\overline{\text{MSN}}$ from C into RAM	1	X	X	0	X	0	X
1 of 2	1	0	1	0	0 1	Let A read $\overline{\text{SUM}}$, add to zero with CARRY, put result into C	0	1 0	X	1 0	f(F)	0	0
$\overline{\text{B}}$	1	0	1	1	0 1		X	0	X	0	f(F)	0	0
LSN	1	1	0	0	0 1	Hold result for rest of count	0	X	X	0	X	0	X
MSN	1	1	0	1	0 1		0	X	X	0	X	0	X
1 of 2	1	1	1	0	0 1		0	X	X	0	X	0	X
$\overline{\text{B}}$	1	1	1	1	0 1		0	X	X	0	X	0	X
	1	1	X	X	X	Hold results until ready to use							

Figure 3.

$J = 1$ for $0 \rightarrow 1$

0 for $0 \rightarrow 0$

$\overline{K} = 0$ for $1 \rightarrow 0$

1 for $1 \rightarrow 1$

0 0 0 0
0 0 0 1
0 0 1 0
0 0 1 1
0 1 0 0
0 1 0 1
0 1 1 0
0 1 1 1
1 0 0 0
1 0 0 1
1 0 1 0
1 0 1 1
1 1 0 0
1 1 0 1
1 1 1 0
1 1 1 1

A

1	X	X	1
1	X	X	1
1	X	X	1
1	X	X	1

X	0	0	X
X	0	0	X
X	0	0	X
X	0	0	X

$J = 1 \quad \overline{K} = 0$

B

0	1	X	X
0	1	X	X
0	1	X	X
0	1	X	X

X	X	0	1
X	X	0	1
X	X	0	1
X	X	0	1

$J = A \quad \overline{K} = \overline{A}$

C

0	0	1	0
X	X	X	X
X	X	X	X
0	0	1	0

X	X	X	X
1	1	0	1
1	1	1	1
X	X	X	X

$J = A \cdot B \quad \overline{K} = \overline{A \cdot B \cdot \overline{D}}$

D

0	0	0	0
0	0	1	0
X	X	X	X
X	X	X	X

X	X	X	X
X	X	X	X
1	1	1	1
1	1	1	1

$J = A \cdot BC \quad \overline{K} = 1$

$+ \overline{A \cdot B} \cdot \overline{C}$

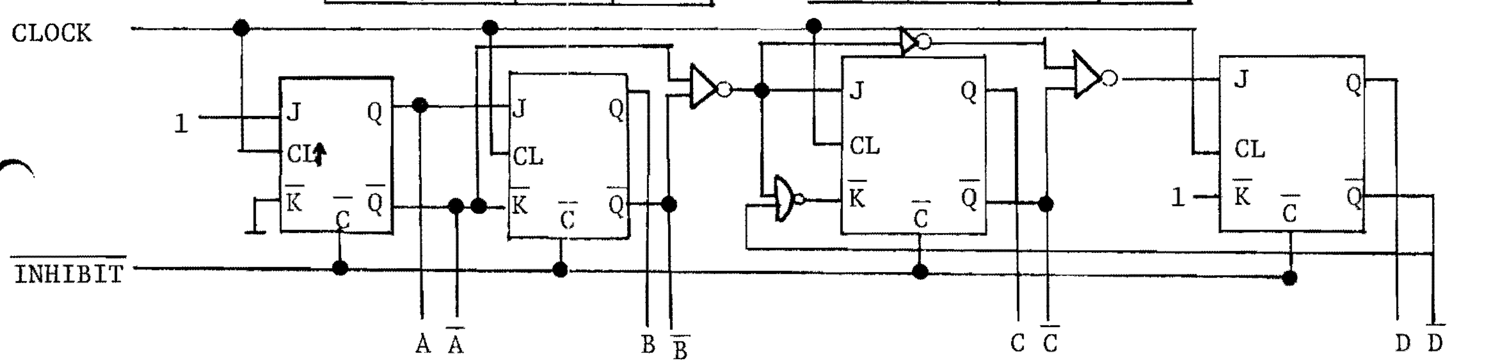


Figure 4.

R/W

0	0	0	0	1	1	0	0
1	1	X	X	X	X	0	0
0	0	X	X	X	X	X	X
1	1	0	0	0	0	0	0

D $\overline{C}$ B

D $\overline{C}$ A

$\overline{D}$ C $\overline{B}$ $\overline{A}$

A & B

1	0	0	0	X	X	X	X
0	0	0/X	0/X	X/0	X/0	X/0	X/1
0	0	0/X	0/X	X	X	X	X
X	X	0	1	X	X	X	X

$\overline{B}$ $\overline{A}$ $\overline{CK}$

D $\overline{A}$ $\overline{CK}$

$\frac{A}{C}$ or $\frac{A\&B}{C}$

$\overline{B}$ $\overline{CK}$

A $\overline{CK}$

C

X	X	X	X	0	0	0	0
1	0	0	1	0	0	0	1
X	X	0	1	0	0	0	0
0	0	X	X	0	0	0	0

$\overline{D}$ B $\overline{CK}$

$\overline{C}$ B $\overline{A}$ $\overline{CK}$

A&B&C

D $\overline{C}$ B A $\overline{CK}$

F

X	X	X	X	0	0	0	0
1	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

$\overline{D}$ B $\overline{A}$ $\overline{CK}$

E

X	X	X	1
X	X	X	X
X	X	X	X
X	X	f(f)	f(f)

$\overline{D}$ Q(f)

G

X	X	X	1
X	I	I	X
X	X	X	X
X	X	0	0

$\overline{D}$

Using presently manufactured devices has proven to be cheaper than the development of a special system of switches just for this circuit. For the memory selection, four miniature snap switches (Cutler-Hammer Type SS12ET30-2L1 with quick connect terminals)will be used. These provide for little pressure to actuate (14 oz.), but a "tactile feel" response so as to assure knowledge that switch has been activated. A supplier for these switches is being sought, however they are available for $1.00 each (1-24 quantities) from Newark Electronics. The weight actuation switch is a pair of snap switches (C-H Type SS10DT40) of the sub-miniature type and cost $2.80 from Newark. The Zero Test switch is a miniature slide switch (DPDT, Alcoswitch Type 2200) which is $0.70 from Newark.

Batteries have been evaluated and two rechargable NiCad batteries will be used. One is approximately 3 volts and the other 6 volts. the six volt battery powers the display and logic; the three volt provides standby power for the memory when not being used for weighing or when the six volt battery is being recharged.

The display will be seven-segment Light Emitting Diodes with an additional ±1 LED. Six of these are required and are approximately $3.00 each. This will be for a 0.625 inch display which should be visible to most people unless their eyes are extremly poor. (These will be about twice as visible as the printed displays now available on mechanical scales.

The circuit has been completely laid out and the printed circuit layout is being developed. The encoder is being developed and for final consideration probably two or more designs will be tested. The final package should look essentially the same as the prototype package with the actual size dependent on mechanical workings and batteries used.

Following is a development of the logic flow within the scale to provide insight to the subtraction, storage section.

LOGIC FLOW

Switch 2 is closed, this is a slide switch at the head of the scales for checking the Zero setting.

All circuits but the memory are activated and the resistor of the Integrated Circuit providing the four second delay is changed to provide instant readout from the encoder that will remain until switch 2 is opened. This provides a means of adjusting spring tension to obtain a true zero reading.

Switches 3,4,5 or 6 closed, these are the memory selection switches.

When any switch is closed it pulls to ground thus setting one of the four Set-Reset latches and clearing the others. If two are pressed only the last will remain set. These also are connected to a One-Shot with a 40 second pulse so that when a switch is pressed all latches are cleared in 40 seconds.

Switch 1 is connected to the weight platform such that if any weight is applied to the scales it will close suppling power to the memory and the display and logic circuitry. When power comes on, the One-Shot with a 4 second delay and a Multivibrator with period of 5 ms. are started. The first will clock a latch from the encoder so as to hold that weight for the rest of the cycle (while weight is applied to the scale). This also holds several J-$\overline{K}$ Flip-Flops in a clear state until the latch is locked to a weight. The Multivibrator then clocks the J-$\overline{K}$ Flip-Flops which comprise the timing circuit of the system which was shown in the previous report. This timing circuit controls the state of the logic circuit through the control signals (A,B,C,E,F, and G). The states of the timing circuit and control signals are explained here (refer to Figure 2 of the previous report).

A clock period is defined to be the consecutive 0,1 states of the CK timing line.

During the first clock period (0000^0_1) the A and B latches are allowed to sample data and then lock on the signal at the 0→1 transition of the CK signal. The data present at the inputs of these latches is the Least Significant Nibble (LSN, least significant four bits of data). The A latch recieves data from the Random Access Memory (RAM), the B latch, from the 1 Of 4 selector which at this time point to the LSN from the encoder latches. The outputs from the A and B latches are input to a four bit adder which adds the numbers.

Nothing occurs during the second clock period (0001^0_1) and the A and B latches are not allowed to read new data.

During clock period three (0010^0_1) several signals change. The memory is allowed to read from the C latch which has data from the 1 of 4 selector which now points to the 1 of 2 selector which points to the SUM from the adder. This SUM is the difference between the present and previous weighings.

During clock period four (0011^{0}_{1}) the 1 of 4 points to the negated output from the B latch which is then stored in the C latch.

In the fifth period (0100^{0}_{1}) the circuit writes the data from the c latch into the RAM thus storing the negated LSN ($\overline{\text{LSN}}$).

In the sixth period (0101^{0}_{1}) the A latch stores the previous MSN from the RAM and B latches the present MSN from the encoder latches through the 1 of 4.

In the seventh period (0110^{0}_{1}) the carry bit from the adder is saved in the F latch. This is the high order carry which determines whether the difference is positive (weight gain) or negative (weight loss).

During the eighth period (0111^{0}_{1}) the C latch stores the negated MSN from the B latch through the 1 of 4 selector.

No information exchange occurs during the ninth period (1000^{0}_{1}).

During the tenth clock period (1001^{0}_{1}) the $\overline{\text{MSN}}$ is written into memory from the C latch.

During the eleventh period (1010^{0}_{1}) the A latch reads and stores the SUM from the RAM and the output from B to the adder is set to zero by the G gate so the adder adds SUM and zero to yield SUM. The carry bit stored in the F latch determines the sign of the SUM and thus selects either SUM or $\overline{\text{SUM}}$ from the 1 of 2 selector. The 1 of 4 selector points to the 1 of 2 and passes the appropriate value to the C latch which stores the value.

In the twelvth period (1011^{0}_{1}) no information changes.

During the thirteenth through sixteenth periods $(1100^{0}_{1} - 1111^{0}_{1})$ the data from the C latch is held and the display is turned on. The clock has been developed to continue counting thirteen through sixteen untill weight is removed from switch 1.

If none of the four memory switches are activated or 40 seconds elapse before weight is applied to the scale, the clock is not allowed to count and memory is not actuated so that only the present weight display is activated.

NOTE: If more than fifteen pounds is lost or gained in a given period weighings the present weight is correct but the difference display will not be valid, it will blink.

Section 3

REQUIREMENTS FOR DESIGN COMPLETION

1. The design of the mechanical switches.
   (a) buy
   (b) build
2. Choice of proper display
   (need minimum power, consider height
3. Necessary battery
   (rechargeable - probably NiCad)
4. Layout of PC board to provide best component location
5. Encoder design -- Rotate brushes v.s. rotate encoder
6. Final package considerations

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

December 7, 1976

Mr. Russel B. Watson, Jr.
Watson Brick & Tile Company
P. O. Box 6483
Tyler, Texas 75711

Dear Mr. Watson:

Enclosed you will find a preliminary copy of our November monthly report relative to your "Weight Watcher" project. As you can see this report builds on the initial monthly report in that our work has included technical modifications tc the results reported previously. It had been our hope to have a working model before Christmas but it doesn't appear that we will meet this deadline. There are no major problems, just the solving of many small technical problems.

We are also awaiting the attorneys' report who are investigating the patentability of the scale. We have no indication whatsoever as to their recommendations at this time. We are keeping the pressure on them to deliver as soon as possible.

Our expenditure for the month of November will be approximately the same as October's sum of $2,600. You will be receiving the formal billing and formal report from our accounting people soon. If there are any questions that we may help you with at any time please feel free to call. I anticipate a meeting with you and your son as soon as the first prototype model is in good working order.

[redacted]

James F. Lowry
Program Manager

JFL:sc
Enclosure

MONTHLY REPORT

A-1899

November 1976

Since the last report on the "Weight Watcher" scales the major goal has been the layout of a printed circuit board and an encoded disk. Construction of the prototype has been started, but has run into some problems.

The logic circuitry is all quite well worked out, but there is a difficulty in the encoder which is being corrected with minor alternations to the design. Rather than using a binary coded disk, a disk providing the on-off function as well as a counter is being developed. This disk will eliminate one of the switches previously required. A disk using gray code is also being considered.

Initial layout of the printed circuit board for the logic proved to have errors which are being worked out.

Battery selection has led to the use of NiCad batteries although lower power circuitry is being sought that would make the necessary recharging of the batteries less frequent.

Final package design still lies ahead, but seems to be heading for a construction using ABS plastic (more modern appearance). A final operating prototype is thus a short time away.

Milton Bennett has forwarded the description of the preliminary patent search to the patent attorneys used by Georgia Tech. We are awaiting a call from the attorneys to set up a meeting date to discuss the device.

Respectfully submitted,

[redacted]

Pini Har-Oz
Project Director

[redacted]

R. L. Yobs
Laboratory Director

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

January 25, 1977

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P. O. Box 6483
Tyler, Texas 75711

Attn: Mr. Russel B. Watson, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1899 for period December 1, 1976 through December 31, 1976

Dear Mr. Watson:

This progress report describes efforts expended through the December period. Activities for this period were limited because of the station's holiday policy.

Attached you will find the patent attorney's preliminary report as to the patentability of the scale. As indicated it appears that even though similar concepts of weighing and storing devices have been disclosed there exists the possibility of limited patent protection on the devices being developed for the scale. It is our current opinion that two potential patents are applicable. One would be a patent on the design using discrete circuitry and the other would be on the microprocessor design currently under development. As per our telephone discussion we will proceed with the patent process on these two items.

At this point in the design of the device it is necessary to select the type of digital device to use in implementing the logic. The two principle options are discrete digital circuitry and microprocessor circuitry. The microprocessor option has been selected because of the lower unit cost of the device, higher reliability and lower product manufacturing cost. These advantages are offset by a higher initial development cost but these are minimal and one-time therefore the microprocessor system was selected.

The selection of a particular microprocessor was required to begin layout and prototype buildup. In the interest of minimizing the initial development cost at Georgia Tech an Intel, Inc. processor was selected because complete development equipment for the Intel microprocessor is available on campus and a number of staff members are well-versed in its use. In the event another microprocessor is desired for the production model, the patent protection is uneffected and only reprogramming will be required.

Efforts through the next period will proceed with the following developments:

1) Microprocessor simulation
2) Selection and purchasing of the microprocessor
3) Interfacing of the mechanical scale with the simulator
4) Package Design
5) Patents

Charges for the month of December will be approximately $1,953.

Sincerely,

[redacted]

James F. Lowry
Program Manager

JFL:sdp

Nancy make decision

LAW OFFICE OF

NEWTON, HOPKINS & ORMSBY

EDWARD TAYLOR NEWTON
GEORGE MARKS HOPKINS
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OF COUNSEL
EDWIN L. REYNOLDS
D.C. BAR

December 20, 1976

Mr. Milton W. Bennett
Georgia Tech Research Institute
Administration Building
Georgia Institute of Technology
Atlanta, Georgia 30332

Re: Preliminary Patentability Search
Digital Scale Device
Your Ref.: ROI 612C
Our Ref.: 0734 - ROI 612C

Dear Milton:

Thank you for your request to conduct a preliminary patentability search on the above-referenced subject matter.

We understand the subject invention to involve a bathroom type scale which has the capability to display not only an individual's weight, but also a weight differential from a previously stored measurement. Weight data is obtained by using a digital disc encoder. The encoder output is fed to a BCD decoder which decodes the user weight. In addition, it is also fed to a one of four multiplexer whose selection controls are governed by one of four operator controlled pushbottons located on the top front of the scale. The multiplexer output is fed to a random access memory and to an arithmetic adder. The adder accepts previously stored weight data from the random access memory and determines a new weight differential which is then outputed to the display. Thereupon the latest weight measurement is stored into the random access memory.

During the course of our search, we uncovered the following references:

Orig-w/encls ROI File 612NC
cc: Mr. Ron Pearl
Mr. P. Har-02 - w/encls
File, A-1899
Diary

3,512,593 - Edmondson
3,655,003 - Yamajima
3,826,318 - Baumgartner
3,869,005 - Williams, Jr. et al.
3,967,690 - Northcutt

[redacted]

USP 3,967,690 to Northcutt discloses a digital read-out diet scale which is capable of detecting and displaying minute changes of weight. The invention comprises a transducer for generating a signal representing the weight of the dieter, and means for storing a signal representing a reference weight for the dieter. These signals are applied to a time gated oscillator whose output is in turn applied to an up-down counter. The counter is responsive to the oscillator output signals to display the dieter's weight or change in weight, and provides a digital display of current weight or weight change. A switching device, is manual or automatic with a time delay, first couples the transducer output to the counter to display the current of the user and then couples the storage means to the counter to decrease the displayed weight by the reference weight, whereby the relative change of weight of the user may be displayed.

USP 3,655,003 to Yamajima discloses a weighing machine which enables a user to recognize at a glance the interrelation between an actual weight of the weighed person and the optimum weight relative to the particular height. Five pushbotton selectors are provided on the top front of the scale and enable the user to select his particular height class.

The remaining references located during the course of the search disclose other weighing devices which are considered to be of interest with respect to the subject invention. However, the references discussed in detail above, appear to be the most pertinent.

During the course of our search, we consulted with U. S. Patent Office Examiner George Miller. As a result of our consultation, we included the following classifications in our field of search:

CLASS 177 - WEIGHING SCALES
- Subclass 2 - With Recorder
- Subclass 3 - With Recorder; With Computing or Totalizing Means
- Subclass 4 - With Recorder; With Recording of a Factor Additional to Weight
- Subclass 5 - With Recording of a Factor Additional to Weight; Weight Identification
- Subclass 25 - Computer

Subclass 164 - Pre-set
Subclass 174 - Pre-set; Indicator Structure; Rack Connection
Subclass 177 - Aluminated
Subclass 210 - Self-positioning; Electrical Current Generating or Modifying
Subclass 213 - Repositioning in Response to Deflection Under Load; Electrical Actuated Poise
Subclass 245 - Combined
Subclass 264 - Miscellaneous
Digest 1 - Allen Digest
Digest 2 - Digitizers Mechanical
Digest 3 - Digitizers Electrical
Digest 4 - Digitizers Non-sensing

As a result of our search, it appears that the broad concept of measuring and storing weight and then computing and displaying weight differential has been previously disclosed. However, the particular implementation of the subject invention appears to be novel. Accordingly, it is our opinion that it would be possible to obtain some limited patent protection on the specific implementation disclosed in the subject invention, if you think that advisable.

It is also our opinion that the present state of the invention is sufficiently advanced that an application can be prepared for submission to the Patent Office without additional design or fabrication. We feel that sufficient information is contained in the materials with which we were provided to enable the application preparation. However, if we were to prepare the application, we would appreciate any additional documentation which is available.

The Season's Best Wishes!

Very truly yours,

NEWTON, HOPKINS & ORMSBY

[redacted]

By: Edward Taylor Newton

ETN:eh
enclosures

Filed May 20, 1968

4 Sheets-Sheet 1

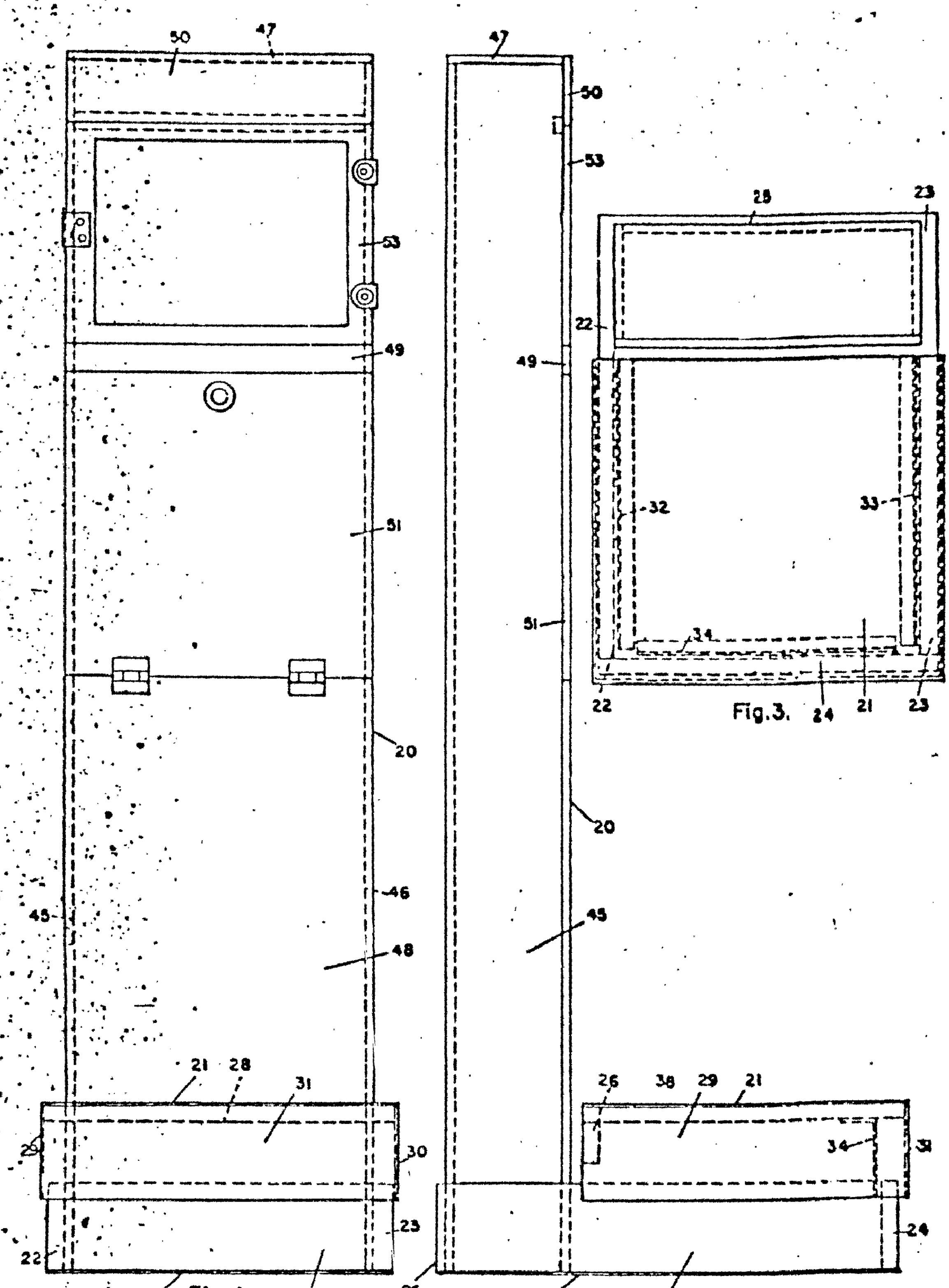

Fig.1.

Fig.2.

Fig.3.

Inventor:
John H. Edmondson,
by Thos. A. Sawyer, Atty.

Filed May 20, 1968

4 Sheets-Sheet 2

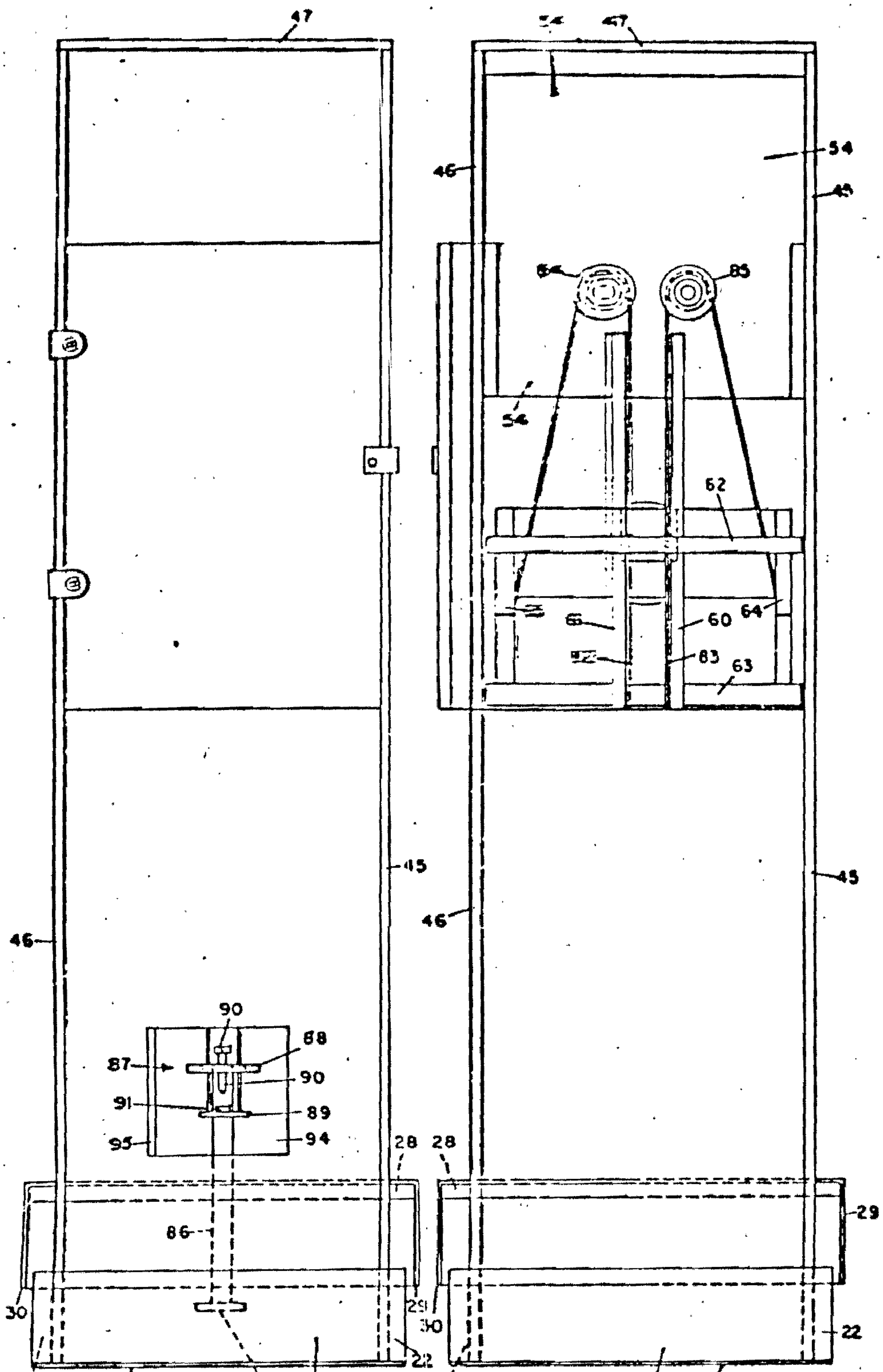

Fig.4.

Fig.5.

Inventor:
John H. Edmondson,
by [illegible] Atty.

Filed May 20, 1968

4 Sheets-Sheet 3

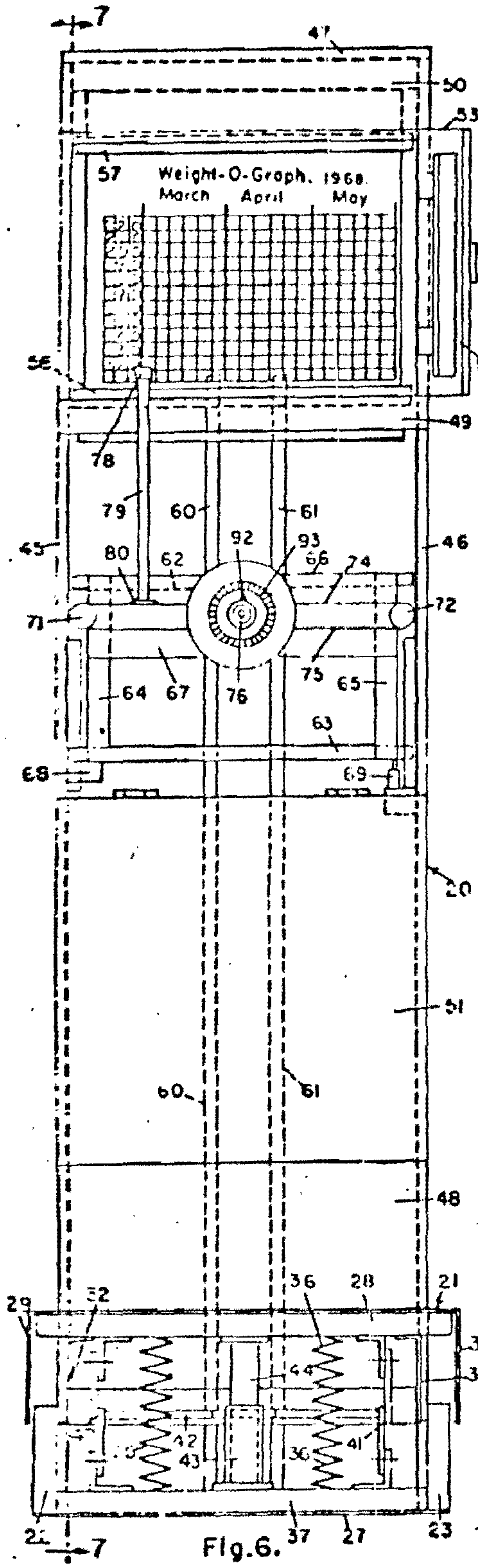

Fig.6.

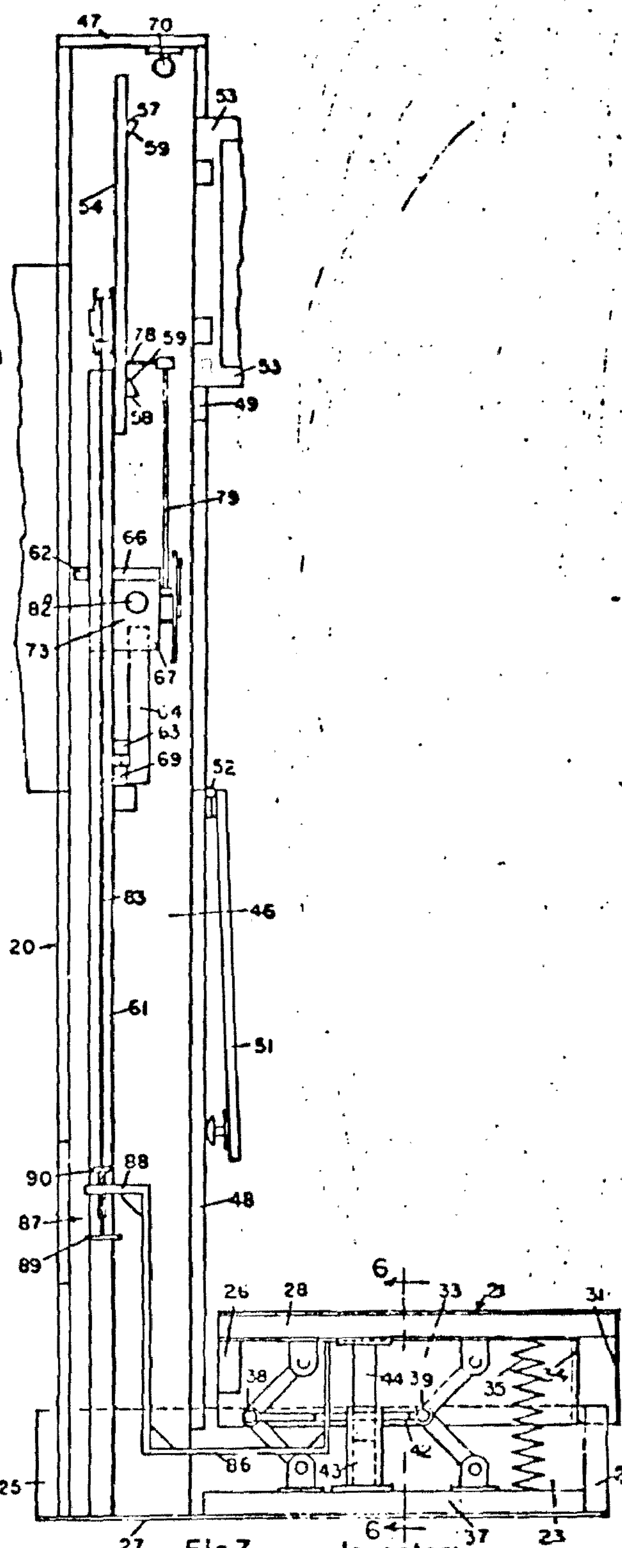

Fig.7.

Inventor:
John H. Edmondson,
by

Filed May 20, 1968

4 Sheets-Sheet 4

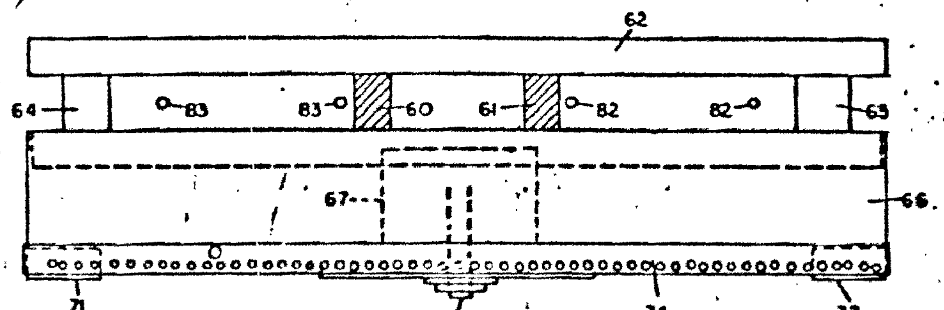

Fig. 9.

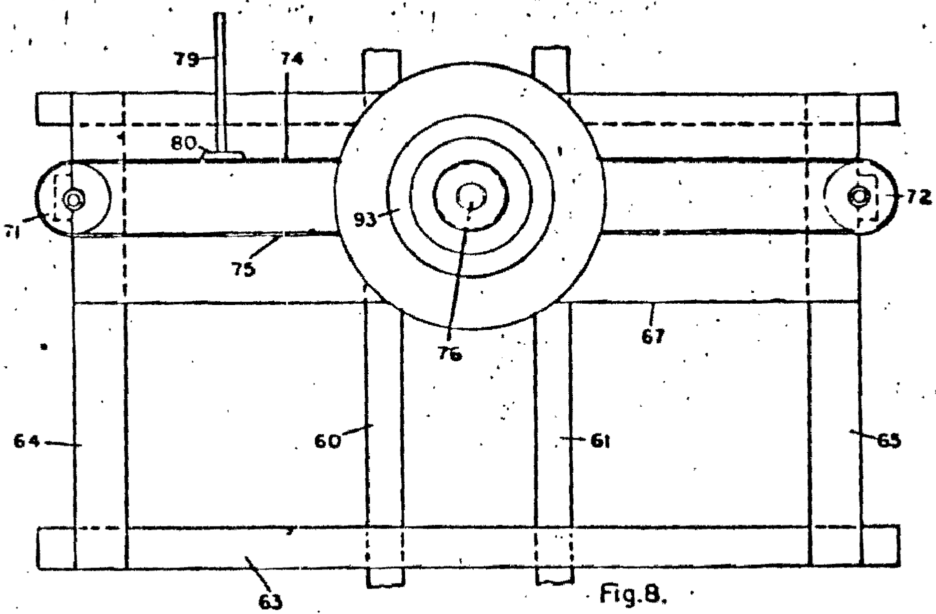

Fig. 8.

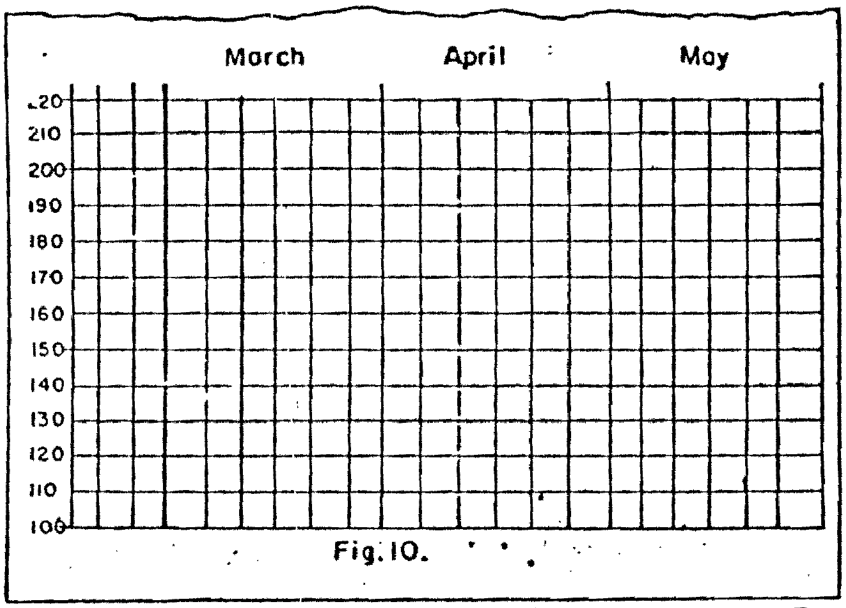

Fig. 10.

Inventor:
John H. Edmondson,
by [illegible] Atty.

United States Patent Office

3,512,593
Patented May 19, 1970

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3,512,593
PERSONAL WEIGHT RECORDERS
John H. Edmondson, 6333 S. Kimbark Ave., Chicago, Ill. 60637
Filed May 20, 1968, Ser. No. 730,332
Int. Cl. G01g 19/40, 23/18
U.S. Cl. 177—5 8 Claims

ABSTRACT OF THE DISCLOSURE

A personal weight recorder for producing a record of day to day weights of a person using such recorder; including provision for producing such day to day record over a substantial interval of time such as three months, with provision for simple and ready removal of the record sheet at completion of such time interval, and substitution of a fresh record sheet, and re-setting of the recording stylus to its starting position. The record is produced and is located at position for convenient direct reading by the person standing on the weigh platform. Provision is made for advancing the recording stylus one day spacing along the record sheet at a time, whether or not a record is made for one or more days, thus ensuring that each record produced on the sheet, will be located at the correct daily recording position, as identified by marking on the sheet.

The present invention concerns itself with improvements in what I shall call personalized record producing of weights of an individual, day by day, over a considerable interval of time. The presently to be disclosed weighing machine is provided with a conventional platform on which the individual stands, and with means to produce a record of his weight on a record sheet; with provision for advancing the record producing stylus laterally across the sheet, step-by-step, day after day, during a considerable interval of time, such as three months. Accordingly, each day a recording is made of the individual's weight on the day in question. If the individual should allow a day or several days to pass without stepping onto the weigh platform, thus missing a record of weight for such time, the stylus of the recorder is nevertheless advanced each day to correct position for producing a record (but without actually producing such record for such day), so that when next the individual does step onto the platform, a weight record for such particular date is produced. Thus the records of weights are properly synchronized with passage of time, producing a time-weight recording over the time interval covered by such record sheet.

Provision is made for removing a used record sheet at conclusion of the time interval covered by such sheet, and substitution of a new record sheet for the succeeding time interval; and provision is also made for re-setting the stylus carrier laterally to its starting position, ready to produce the succeeding set of recordings over the next time interval.

A simple type of record is one generally known as the bar-type, wherein after each recording is produced, the stylus re-sets back to its base position, with lateral advance of the record sheet, or, as in the present disclosure, lateral advance of the stylus, the record sheet remaining stationary. In producing such bar-type recording, the weight imposed on the platform serves to raise the stylus to a height corresponding to the weight imposed; and after removal of the weight from the platform, the stylus falls back to its base or zero position. The lateral advance of the stylus carrier then brings such stylus to its properly laterally re-set position for the next day's recording operation. Having produced such a bar-type recording, the student thereof may, should he so desire, produce a continuous line extending laterally along the tips of the

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successive bars, thus facilitating study of the information available from such recording over the time interval in question. Recorders incorporating the features of my present invention are thus of use for home installations, for hospitals, clinics, and numerous other purposes wherein it is desired to integrate time with weight. Thus, weighing machines embodying features of my present invention are useful in studying the progress of a weight-reducing diet, or the recovery of a patient from a serious illness, measured by his progress in weight recovery, or conversely, the advance of a disease, measured by the progress in loss of weight; and many other useful purposes available from the use of machines embodying features of my present invention, will suggest themselves.

More specifically, it is an object of the present invention to provide for producing a lineal variation of the stylus movement with equal variations of imposed weight. Such objective is served by provision of a conventional platform on which the patient stands during the weighing operation, together with means to ensure that the desired lineality of recording shall be produced, regardless of the exact part of the platform supporting his weight. To this end I have provided a spring supported platform without pre-loading of the springs, so that the graph between loading and variation of strain, shall be linear, with the intersect extending through the zero position between the ordinates and the abscissae of a characteristic curve of such arrangement. I have also provided an arrangement wherein the displacement of the connection between the platform and the movement transmitting element to the stylus, shall always indicate correctly the imposed load, no matter which part of the platform may carry the imposed load. Thus, whether the patient stands on the center of the platform, or forwardly or backwardly of such center, or to one side or the other of the platform, the displacement of the connection between the platform and the stylus, shall be a true indication of the supported load, measured on a linear scale. The details of this arrangement will appear hereinafter.

It is a further object of the invention to provide a simple, directly operating, and rugged structure, constituted to produce records of dependable accuracy, and of construction not liable to damage by sudden violent depressions of the platform, such as may occur by customary stepping onto such platform for the weighing operation.

Other objects and uses of the invention will appear from a detailed description of the same, which consists in the features of construction and combinations of parts hereinafter described and claimed.

In the drawings:

FIG. 1 shows a front view of the weighing machine, both of the front doors being closed, and the platform being in its normal or raised position, occupied when no weight is imposed on such platform;

FIG. 2 shows a left-hand elevational view corresponding to FIG. 1;

FIG. 3 shows a plan view corresponding to FIGS. 1 and 2;

FIG. 4 shows a back or rear view corresponding to FIGS. 1 and 2;

FIG. 5 shows a view corresponding to FIG. 4, but with the back side door opened to show some of the interior structures;

FIG. 6 shows a front view corresponding to FIG. 1, but with the upper and lower front doors opened; the former showing the record sheet in place supported by the record carrier, and also showing the stylus in its lowered or zero position, and at its left-hand moved position, being its starting position for producing a record day by day stepping rightwardly towards the right; and in this figure the platform structure is shown in section according to an irregular section taken on the line 6—6 of FIG. 7, looking in the direction of the arrows;

FIG. 7 shows a vertical central section through the entire machine, being a section taken substantially on the line 7—7 of FIG. 6, looking in the direction of the arrows;

FIG. 8 shows a fragmentary front face view of the time counting element by which the stylus carrier is advanced laterally to the right for location day by day in positions correct for producing the bar type records corresponding to the weights imposed during weighing tests produced on such days; this figure being on larger scale than FIGS. 1 and 6;

FIG. 9 shows a fragmentary plan view corresponding to FIG. 8; and

FIG. 10 shows a face view of a typical chart for use in connection with the machine of the present invention, removed from such weighing machine, being on enlarged scale as compared with FIG. 6.

Referring to the drawings, the weighing machine includes the vertical section 20 and the horizontal platform section 21, connected to the lower end of such vertical section 20. Conveniently the platform section comprises the side bars 22 and 23 having their front ends connected to the front bar 24 in rigid manner. Such side bars extend rearwardly far enough to embrace the lower end of the vertical section, as shown in FIGS. 1, 2 and 3 in particular. A rear cross bar 25 connects the rear ends of such side bars together, thus producing a rigid rectangular base frame. If desired a cross piece 26 may be extended between the side bars 22 and 23 just in advance of the lower end of the vertical section 20, but set above the bottom face of the platform section, to enable necessary connections between the platform and vertical sections, hereinafter to be described. The bottom face of the platform section is closed by a sheet metal plate 27. The upper portion of such platform frame remains open, the vertically movable platform 21 being located above and telescoping around such platform frame section. Thus such platform section 21 includes the stiff sheet 28 extending between the side angles of sheet metal 29 and 30 which depend from such sheet 28, and the front angle 31 which extends down from such sheet 28. All three of such downwardly extending angle members 29, 30 and 31 are set out far enough to slightly clear the outer perimeters of the frame member 22, 23 and 24, and such angles also depend slightly lower than the upper edges of such frame members, as shown in FIGS. 6 and 7 in particular. Thus a telescoping arrangement is produced, wherein the platform proper may be depressed sufficiently to balance the greatest load to which the weighing machine is intended to receive. If desired, the downwardly extending angles 32 and 33 may be provided along the side portions of the sheet 28, extending down proximate to the inner faces of the platform frame bars 22 and 23, respectively, but spaced therefrom sufficiently to avoid interference with the up and down movements of the platform proper. Likewise, another downwardly extending angle 34 may be secured to the plate 28, extending down therefrom just behind the front platform frame bar 24 and clearing the same sufficiently to avoid interference with the free up and down platform movements. All such downwardly extending angle elements which are connected to the platform sheet 28, serve to prevent excessive lateral and front to back movements of the platform proper with respect to the platform frame; but such lateral and such front to back movements of the platform proper are also controlled by the elbow units and connections presently to be described, and which will normally retain the platform against lateral sway or front to back shift within a very small tolerance. It is also noted that such elbow units serve to ensure up and down movements of the platform proper without lateral or front to back shift of such platform unit, for purposes of ensuring accurate weight measurements, and transmittal of such measurements linearly to the stylus operating elements, as will hereinafter appear.

The springs 35 and 36 are secured to the bottom plate 37 of the platform frame, the side bars 22 and 23, and the bottom sheet 27 being connected to such bottom sheet. Thus the lower ends of the springs are rigidly retained against movement with respect to the platform frame in particular. The upper ends of such springs just reach to the under face of the sheet 28, being attached thereto in manner to prevent side-wise or lateral shift of such upper spring ends. Such springs are not loaded when no load is carried by the platform, so the springs will be deformed according to a linear deformation under varying platform loadings. Two elbows are located between each side of the platform and the sheet 37 directly below, these being the elbows 38 and 39 at the left-hand side of platform, and 40 and 41 at the right-hand side of the platform. Each such elbow comprising the two links *a* and *b* pivotally connected together, and with their upper and lower ends pivotally connected to brackets secured to the platform plate 28 and to the base plate 37, respectively. All such links are of the same length (measured between their two pivotal connections). Accordingly, when the pivotal point of the links *a* and *b* of one elbow 38 is connected by a link to the pivotal point of the links *a* and *b* of the elbow 39, provided that the length of such so interconnecting link is the same as the distance between the brackets to which the links *a* of the one elbow 38 and the other elbow 39, are connected to the platform, and also the same as the distance between the brackets by which the links *b* of such elbow 38 and the other elbow 39, are connected to the base plate, the platform above such two pairs of links, or elbows, must rise and fall while retaining the platform always parallel to itself. A similar reasoning must also apply respecting the two elbows 40 and 41 at the other side of the platform. By making the interconnecting links between the elbows 40 and 41 the same in length as such aforesaid link between the elbows 38 and 39, both sides of the platform must rise and fall while remaining parallel to such platform and parallel to the base plate. By integrating the interconnections of both pairs of elbows (38–39, and 40–41), both sides of the platform must always rise and fall parallel to the base plate, the vertical movements of the platform always occuring while the platform remains parallel to itsef. That is, all vertical movements of the platform will occur under the condition that such platform always remains parallel to a common and unvarying plane. Such integration of the two interconnections is produced by providing the plate 42 having its corners pivotally connected to the four elbows at their link interconnected ends, such plate 42 being of rectangular form. With this or corresponding structure, any load applied to any portion of the area of the plaform will cause such platform to descend with its surface always parallel to itself, and always parallel to the base plate 37. Thus, when the patient steps onto the platform the depression of all of the springs 35 and 36 will be equalized, and such depression will be linear in amount, that is, equal spring compressions will be produced by equal increments of the loading. Accordingly, a direct connection between the platform and the stylus, presently to be described, will produce equal increments of stylus movement during recording.

It is now noted that lateral forces exerted against the platform will be resisted by the pivotal connections to the corners of the plate 42, tending to bend such pivotally connected corners. A small degree of such lateral force would probably not produce such bend; but to insure against such possibility, and to ensure protection of the parts against such lateral force, I have made the following provision;

I have provided the cylinder 43 extending upwardly from the central portion of the base plate 37 and secured thereto, together with a companion plunger element 44 secured to the under face of the platform sheet 28 and extending into and working in such cylinder with a nice fit. The cylinder and the plunger are proportioned so that a substantial length of the plunger will always be telescoped into the cylinder, sufficient to resist lateral deformation, and thus to protect the plate 42 against the distortion already referred to. Additionally, the sheets 29 and 30, and 32 and 33, and 31 and 34 which depend from the platform in telescoping manner with respect to the base frame elements, may be designed and located at small clearances from such base frame elements, to thus come into engagement therewith, by small deflections produced by relatively small lateral forces. Additionally, the telescoping of such elements with the base plate frame elements will protect against entrance of foreign materials into and between the relatively movable elements of the platform structure.

The vertically extending portion 20, of the machine, reaches up from the rearwardly extending base elements 22 and 23, together with the cross-wise extending element 24, already referred to. Accordingly, such portion 20 is firmly connected to the weighing platform structure.

Such vertically extending portion includes the side plates 45 and 46, together with the front and back panels and the top element 47. The front panel or enclosure includes the lower panel 48 which extends up to a large opening defined by the top edge of such lower panel and a cross-wise extending bar 49; and a viewing opening is defined by such bar 49 and the lower edge of a top panel 50. The first mentioned opening is provided with the hinged door 51, hinged to the top edge of the panel 48 by a piano type hinge 52 in conventional manner. Such door 51 may thus be raised into closed position and locked in convenient manner. The viewing opening is provided with a side edge hinge or hinges carried door 53, and suitable locking facilities are provided for locking such door when closed. Such door is provided with a large window, preferably of glass, through which the whole area of the chart undergoing recording, as well as the upper portion of the stylus carrier, may be viewed without need of opening the door. As successive days pass the stylus advances rightwardly by the structures presently to be described. The chart shown in FIG. 6 is typical of charts which may receive the desired recordings. One such chart is also shown enlarged in FIG. 10. Such chart may be provided with light ordinal lines defining calendar intervals, such as successive days, or as shown in FIGS. 6 and 10, defining successive five day intervals, since the scales to which such figures are drawn make it inconvenient to show successive days. Furthermore, the defining of such canendar intervals by ordinal lines should be of such fine or semi-transparent character as not to obscure or even materially reduce the emphasis of the recorded bar produced on such line. The manner in which the stylus is advanced rightwardly with passage of time, will be disclosed presently.

The illustrated chart also includes abscissa lines extending across the chart at successively higher positions. These lines indicate weights; and the height of the bar record at any give date or time interval, may thus be immediately determined by the height of the bar corresponding to such calendar time. It is noted that in the illustrated chart the lowest weight indication is for 120 pounds, and the stylus illustrated in such figure stands at such low weight position. Since the stylus movement related to weight impressed on the platform is linear, it is evident that for the condition of no weight on the platform, the stylus should, in the absence of special provision, be much below such 120 pound indication. Accordingly, I have, in the structures presently to be described, made provision for a lost-motion between the directly platform connected element, and the element connecting to the stylus, enabling platform movements of less than 120 pounds weight indication, to occur freely without causing stylus rise; and such lost-motion connection produces force transfer from the platform to the stylus, only when a load of 120 pounds or more is carried by the platform. Evidently, some other lost-motion amount, either more or less than 120 pounds may be provided for. It is also noted that by thus eliminating recording of weights less than a prescribed value, the space available for producing records on the chart may be used either for recording to higher values under a specified detail of recorded bars, or for recording to a given high value, at prescribed higher detail of the recordings.

The chart is readily insertable in place or removed therefrom as follows:

A plate 54 is extended across the upper portion of the structure between the side panels 45 and 56 of the element 20. The front face of such plate 54 is provided with top and bottom chart receiving and supporting clamps 57 and 58, respectively. These clamps may be of conventional form, comprising the spring pressed strips 59 which press the edge portion of the chart carrying paper or card against the front surface of such plate 54 in conventional manner. With such structure the chart is readily inserted into or removed from the plate; and by properly sizing the spacing between the two clips, vertical adjustments of the chart to exact vertical calibration for correct weight recordings, may be produced. Lateral adjustments of the chart may also be produced to ensure correct calendar readings for the several bar-type records to be made by the stylus.

Two vertical bars 60 and 61 are extended from such plate 54 to the bottom of the structure, and are secured to such plate 54 and to the bottom of the structure. These bars afford guidance for the stylus carrier during up and down movements of such carrier, as will be presently explained.

The stylus carrier comprises a light frame including the top and bottom bars 62 and 63, respectively, together with the vertical struts 64 and 65 to which such top and bottom bars are connected. Examination of FIG. 7 in particular shows that the top bar 62 rides against the back surfaces of the two vertical bars 60 and 61, whereas the bottom bar 63 rides against the front surfaces of such vertical bars. Thus torques produced by the weight of the frame and connected elements, tending to rock such frame clockwise, viewed as in FIG. 7, are properly taken up. Additionally, a top board 66 is provided in such frame, such top board riding against the front surfaces of the bars 60 and 61. A box-like element 67 is secured to and comprises a portion of the frame in front of the bars 60 and 61. This box-like element encloses a time counting unit, such as an electric synchronous motor unit, to be referred to hereinafter.

A stop element 68 is secured to the left-hand plate 45 in position to limit the downward movement of the frame at a zero or base position, wherein the stylus is engaged with the chart surface at its low weight position (as shown in FIG. 6 such low weight position is the 120 pounds recording position). Secured to the opposite side panel 56 below the frame is a switch, such as a microswitch 69, having its actuating pin extending upwardly into position for engagement by the frame just prior to stoppage of the downward movement of the frame, produced by the stop 68. Such switch has its contacts biased to close circuit just as the frame rises during a recording operation. Normally, when the frame is in its fully lowered position such switch is open circuited. Such switch is connected to a conventional service outlet for current; and a lamp 70 is secured to the top plate 47 of the structure, being connected to such current outlet through the microswitch. Accordingly, such lamp is normally un-lighted while the frame is in its fully lowered position; but as soon as the frame rises slightly by weighing force transmitted from the platform, the microswitch closes, thus lighting the lamp, and illuminating the front surface of the chart. Such illumination continues during the interval of weighing, but ceases as soon as the weight is removed from the platform.

It remains to describe the means which I have provided for advancing the stylus laterally of the chart at a rate to shift from position proper to produce the record-bar for one day weighing, to position proper for producing the recording for the following day. This is a slow lateral travel, and is conveniently produced by a small synchronous motor driven gear-train enclosed in the box-like unit 67, and continuously supplied with conventional A.C. 60 cycle supply. The gear-train is such as to produce lateral travel of the stylus only from one bar-like recording position to the next, during the interval between recordings, assume as 24 hours. In the chart showings of FIGS. 6 and 10, provision is made for ninety days of recordings. Accordingly, the stylus should travel the full width of the chart during a ninety day interval.

Reference is next made to FIGS. 6, 7 and 10 showing the lateral drive means for travelling the stylus from ordinal position to ordinal position, laterally, already referred to. This structure includes the synchronous motor drive, of more or less conventional form, geared to produce the desired slow lateral travel rightwardly, of the stylus. It is unnecessary to describe such unit in detail since various small synchronous motor driven geared-down units are well known in the arts. The small pinions 71 and 72 are journalled to the unit 67 at the sides of the structure, being separated a distance sufficient to accommodate the needed travel of the stylus carrier. A thin flexible metal tape (e.g., of steel), in the form of a loop is extended over such pinions, thus providing the straight runs 74 and 75. The output shaft 76 of the gear reduction train carries a small toothed wheel 77 which engages corresponding sprocket tooth openings along one edge of the tape loop, it being noted that since the tape runs travel in opposite directions both runs of the tape may be drivingly engaged by the toothed wheel.

The stylus 78 is carried by a vertical stem 79 whose lower end is secured to the tape run in manner such as to prevent deflection of such stem laterally, so that it retains its verticality during the entire lateral travel needed to produce recordings for the total time interval intended. For this purpose the stem 79 is shown as connected to a small base plate 80 firmly secured to the top run of the tape.

Since the lateral travel of the stylus carrier is limited it is desirable to provide means to cut off the current supply to the synchronous motor at the right-hand end of the permissible travel. The microswitch 81 mounted to a stationary part adjacent to the extreme rightward travel of the stylus carrier, is engaged by the stylus carrier or some element carried by the tape, at completion of such rightward travel of the top run of the tape, thus cutting off current supply to the motor. If desired such switch may be of that type wherein one depression of a contact controlling element serves to open the switch, and the succeeding depression of such element serves to close the contacts; it being noted that after stoppage of the motor drive, it is necessary to return the sylus carrier leftwardly to its starting position, preparatory to a succeeding series of recording operations. A re-setting button 82ª is shown in FIGS. 7 and 10, at the location of the motor. This button when actuated serves to re-set the output shaft of the motor's gear train backwardly, to cause the toothed wheel to drive the tape inreverse direction, necessary for such re-setting. During such re-setting the microswitch 81 remains open-circuited. When the recorded chart has been removed and a fresh chart has been set into place, and properly adjusted laterally and vertically to cause the stylus (now at its lowered position) to register with the starting first day ordinal line, and the low weight position of the chart, the micro-switch may be reversed to closed circuit position, thus starting another thirty day or three month series of recordings.

The stylus frame is movable upwardly from its lowest position (stopped in downward movement by the stop

block 68, see FIG. 6) when the weight on the platform exceeds the minimum for which the record chart is intended. Such upward movement of the stylus is produced by raising the stylus carrier frame when the weight imposed on the platform exceeds such chart minimum record value. For producing such operation I have provided the two cords 82 and 83 connected to the vertical frame bars 64 and 65 (see FIG. 5), which cords are carried up and over the pulleys 84 and 85 journalled to the rear face of the plate 54, and then down between the vertical bars 60 and 61 to a point of connection with the bar 86 which extends rearwardly from the platform, and beneath the vertical machine section 20. The connection between the cords 82 and 83, and the bar 86 may be a direct connection, or, as shown in detail in FIGS. 4 and 7, it may include a lost-motion unit for the purpose explained below.

When the connection between such cords and the bar 86 is a direct connection, it is evident that as soon as weight is imposed on the platform, the stylus carrier and stylus will start to rise from a base or zero weight position. Accordingly, such a direct connection arrangement may be suitable when the markings on the chart start at zero weight, corresponding to the fully lowered position of the stylus, and when the weight markings on the chart increase in direct linear ratio as the imposed weights increase by equal increments. But it is evident that, if it be desired to provide an arrangement in which the fully lowered position of the stylus corresponds to some definite weight (shown on the illustrated chart as "120"), then impositions of weights less than such selected minimum (e.g., 120) must not cause rise of the stylus from its base position. Furthermore, the arrangement must be such that as weights greater than such minimum are imposed on the platform, the stylus will be driven upwardly by equal increments of upward movement, corresponding to equal increments of imposed weight, greater than the selected minimum. Such an arrangement is desirable from several standpoints. For a vertical dimension of available chart, and for vertical advances of the stylus corresponding to successive equal increments of weight, it is evident that only a limited number of such increments may be accommodated in such available vertical dimension, allowing satisfactory sized spaces between the increments—that is, for production of a satisfactory detail of the readings of weights greater than such minimum weight. When the machine is intended for weighing imposed weights more than relatively small ones (e.g., not over 100 pounds), and with a chart height of, say five inches, the spacings between successive weight increments of 5 pounds may be 1/20 of five inches, or 1/4 inch. With such a scale spacing, and for recording weights of, say 200 pounds, and starting chart recordings at zero weight, and with recording of weight increments of 5 pounds as before, need would exist for accommodation of 40 recordings of 5 pounds each; and when retaining the same vertical dimension of the chart (5 inches), it is evident that the successive recordings would be 1/8 inch apart, being one-half of the spacings available when the upper limit of weight was 100 pounds. Such a small spacing between successive weight increments, might be found unsatisfactory.

Following the foregoing analysis, if the device be such that no stylus movement will occur from its fully lowered position until a minimum recordable weight of 100 pounds be imposed on the platform, then the still available recording space being 5 inches, it will now be necessary to produce only 20 recordings of 5 pounds each between 100 pounds and 200 pounds, and it will now be possible to obtain the original detail of 1/4 inch between successive five pounds increments, over the differential between 100 pounds and 200 pounds. Thus, by making provision for starting at pre-determined minimum recorded weights, it becomes possible to chart record weight above such minimum, and up to a desired maximum, within a chart height much less than otherwise would be needed, and without sacrifice of detail. The presently disclosed structures make such provision, which will now be described.

Referring to FIGS. 4 and 7 I have provided a lost-motion unit 87 between the bar 86 and the cords 82 and 83, such that as the bar 86 is lowered by imposition of increasing weight on the platform, drive of the cords downward (for rise of the stylus carrier) will not commence until such lost-motion has been taken up. Such lost-motion unit includes as an extension 88 of the bar 86, extending across the lines of the two cords 82 and 83, such cords then being connected to a plate 89 below the extension 88. For this purpose the extension 88 is provided with holes through which the cords are passed, to the plate 89. This arrangement will prevent shift of the plate 89 from proper alignment with the extension 88, which alignment is needed to produce adjustment of the lost-motion, as will now appear.

A screw 90 is threaded through the extension 88 and may be adjusted to bring its lower end an adjusted distance from the plate 89. Conveniently such plate 89 is provided with a recessed and 91 to receive and exactly center the screw as it descends (under increased weight imposed on the platform), thus ensuring that driving engagement will occur from the screw to the plate 89 at an exactly determined descent of the platform, corresponding to a pre-determined imposed weight. Thus, start of rise of the stylus with increasing imposed weight will occur at the base or lower weight marked position of the chart. If desired the screw may be provided with markings designating imposed weights at which stylus rise will begin, for the following reason, among others.

I contemplate the use of charts scaled and marked for various ranges of weights to be recorded thereon, and all such charts being marked with weight recordings spaced at equal values of detail. For example, if the detail be selected as such that between low and high readings on various chart forms, the recorded weights of minimum and maximum be sixty pounds, with marked weights five pounds apart, it will be evident that twelve such recording marks may be accommodated within the assumed recording height of five inches, each such mark designating an increase of five pounds weight over the marking for the next lower marked position. On this basis, various charts may be produced, each being provided with a vertical recording space of five inches height, provided with twelve increments, each of five pounds. A series of such charts might be as follows.

Chart form:	Pounds
A	0–60
B	60–120
C	120–180
D	180–240
E	240–300
F	300–360
G	360–420
H	420–480

By properly setting the adjustable lost-motion unit for commencement of weight recording at the low point of the chart to be used, the recordings produced on such chart will be of the same detail as recordings produced for other selected charts and corresponding weight ranges.

It will be noted that each of the chart forms suggested in the foregoing tabulation is of the same overall vertical recording space as each of the other chart forms. Accordingly, any selected form may be set into and clamped in place on the plate 54, and adjusted vertically, to bring its low reading chart marking to exact registry with the stylus when such stylus is at its low or starting position, determined by the stop block 68 (FIG. 1). Then, having adjusted the lost-motion unit 87 to take-up at the low recording position of such selected chart, the stylus record will commence at the low weight position shown on such chart. Such adjustment of the lost-motion unit may be, as previously suggested, by provision of suitable comparison marks, or by empirical test.

The chart illustrated in the drawings shows three month areas. It is intended that vertical ordinal lines shall be provided corresponding to each day (or, in case of excessive crowding by such daily ordinal markings), each group of several days (e.g., five), with calibration of the motor drive at such rate that during each 24 hours the stylus shall advance the proper distance corresponding to such single day (or such group of days). Accordingly, the ruling of each chart for a given month may be inclusive of either thirty or 31 ordinal lines (or 28 for February), thus exactly coordinating each monthly chart with the proper number of days recorded, and with the recording for each day being correctly indicated on the ordinal line for such specific day.

If desired a pointer 92 (see FIG. 6), may be connected to the output shaft of the gear reduction element through which the lateral travel of the stylus carrier is produced. When the gear drive to the tape 74–75 is such that one rotation of the shaft 70 corresponds to a specified number of days (e.g., 30), the pointer 72 may be read on a circular scale, to show the day of the month currently being recorded, the scale 93 being properly calibrated for this purpose.

Referring again to the lost-motion unit, the provision of the vertical section of the bar 86 serves to raise the lost-motion unit to a height corresponding to such vertical section. I have provided the opening 94 in the rear wall of the vertical section 20 of the machine, such door giving access to the lost-motion unit for convenient adjustment of such lost-motion, corresponding to the positioning of the stylus carrier at the proper starting position, according to the starting weight to be recorded on the chart. A door 95 may be provided for protection of such adjusted position, against tampering by unauthorized persons.

I claim:

1. A weighing machine comprising in combination; means to support a chart sheet carrying ordinal lineations corresponding to progressively higher weight showings, which ordinal lineations are located at progressively spaced abcissa locations corresponding to equal timing positions across the chart; together with a stylus carrier proximate to such chart, means to advance said stylus carrier laterally across the chart sheet from ordinal line position to ordinal line position at equal time intervals, a stylus carried by the stylus carrier and in marking engagement with the chart sheet; a weighing platform, spring means to sustain said platform at a non-load position, and constituted to permit depression of the platform with progressively greater loadings carried by the platform; and connections between the platform and the stylus carrier, constituted to raise the stylus carrier to progressively higher positions corresponding to progressively greater platform loadings, with movement of the stylus to progressively higher positions on the chart and production of bar-type recordings on the chart at ordinal positions of the chart corresponding to the laterally moved positions of the stylus carrier, and with return of the stylus to its base position when the platform is unloaded.

2. A weighing machine as defined in claim 1; together with a lost-motion unit comprising a portion of the connections which are between the platform and the stylus carrier, constituted to permit lowering of the platform under a pre-determined base weight on the platform and non-movement of the stylus carrier during such platform movement, and with recording movement of the stylus during platform lowering under weight greater than such base weight.

3. A weighing machine as defined in claim 2; wherein the lost-motion unit includes adjustable means constituted to vary the amount of lost-motion in the connections which are between the platform and the stylus car-

rier, with corresponding change of the base weight at which the stylus commences recording, and corresponding change of the range of platform weights recorded by the stylus.

4. A weighing machine as defined in claim 2; wherein the lost-motion is adjustable to different amounts of lost-motion, corresponding to different base weights at which the stylus commences recording operations.

5. A weighing machine as defined in claim 4; wherein the chart supporting means includes means to removably support a selected one of a series of different charts, corresponding to different adjustments of the lost-motion of the lost-motion unit.

6. A weighing machine as defined in claim 5; wherein each chart of such series of charts includes a low-reading indicia corresponding to a permitted weight loading of the platform with non-movement of the stylus carrier in recording direction.

7. A weighing machine as defined in claim 2; wherein the differential between weight-recording movements of the stylus carrier and increments of weight-recorded movements of the platform, is linear.

8. A weighing machine as defined in claim 6; wherein the low-reading weight indicia of each chart of the series corresponds to a permitted weight-loading of the platform with non-movement of the stylus carrier corresponding to an adjustment of the lost-motion unit.

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ROBERT S. WARD, Jr., Primary Examiner

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United States Patent [15] 3,655,003
Yamajima [45] Apr. 11, 1972

[54] WEIGHING MACHINE

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[73] Assignee: Kabushiki Kaisha Tanita Seisakusho, Tokyo-to, Japan

[22] Filed: Sept. 23, 1970
[21] Appl. No.: 74,684

[52] U.S. Cl. 177/173, 177/177, 177/210, 177/245
[51] Int. Cl. G01g 23/30, G01g 19/413
[58] Field of Search 177/34, 48, 164, 173, 177, 177/210, 211, 245, 264

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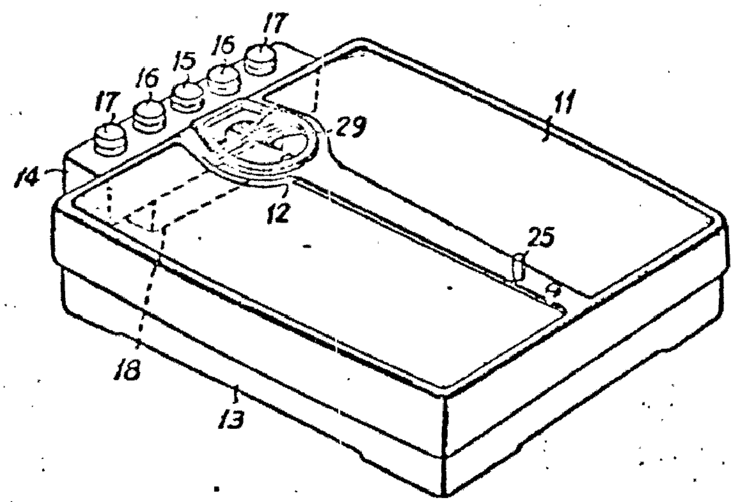
Primary Examiner—Robert S. Ward, Jr.
Attorney—Steinberg & Blake

[57] ABSTRACT

A weighing machine comprising a platform on which an individual stands, and a base for supporting the platform through a weighing mechanism. A movable contact is adapted to be rotated in unison with a weight scale disc which is, in turn, rotatable by an amount in proportion to the load placed on the platform, a plurality of slidable contact plates being opposed to the movable contact, and a plurality of lamps being adapted to be separately lit as the contact is rotated through engagement with the slidable contact plates. And an adjustable height scale ring is arranged in concentric relation with the weight scale disc peripherally bearing a height scale and carrying the slidable contact plates, with which a weighted person may recognize at a glance the interrelation between an actual weight of the weighed person and the optimum weight relative to a particular height of the weighed person according to a lit lamp and the lamp corresponding to the optimum weight through operation of manually coordinating the height scale ring to the weight of the weighed person.

9 Claims, 3 Drawing Figures



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SHEET 1 OF 2

FIG. 1

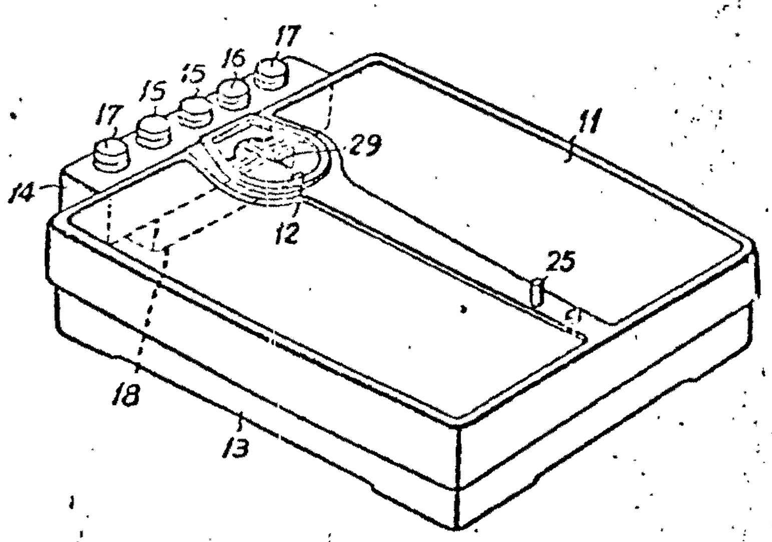

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FIG. 2

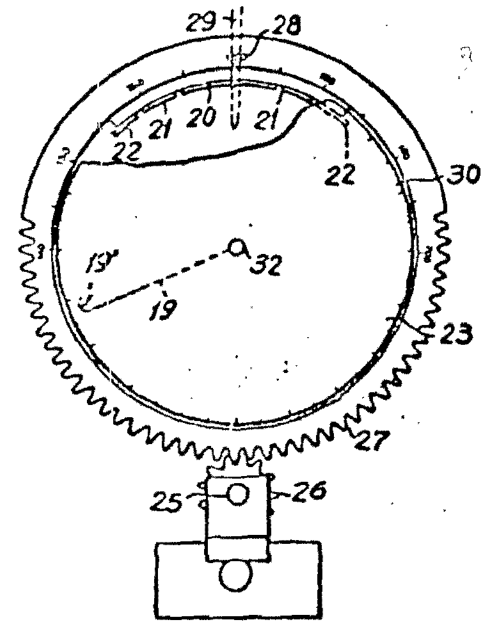
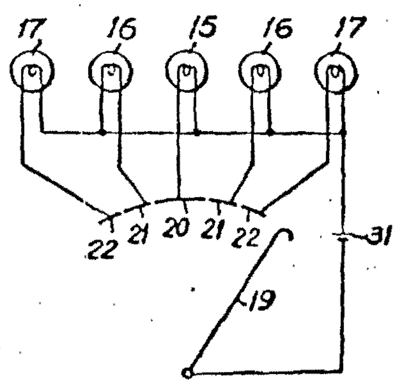


FIG. 3



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WEIGHING MACHINE

BACKGROUND OF THE INVENTION

A weighing machine is well known of which a part bears an indication of the optimum relation between height and weight in the human body by which it is possible to calculate the relation between the actual weight and height of the weighed person and the optimum interrelation. This comparison, however, is usually accomplished on the basis of a comparison scale provided on a part of the weighing machine. With such a weighing machine, therefore, the weighed person has had to read anew his or her own weight on the comparison scale after determining his or her own weight. It would be very convenient for the weighed person if the interrelation between his or her own actual weight and the optimum weight for his or her own actual height can be recognized in concurrence with weighing and it is extremely desirable that the degree of over or under weight relative to the optimum weight can be recognized.

SUMMARY OF THE INVENTION

The first object of the present invention is to provide a weighing machine having a weighing mechanism adapted to indicate the optimum relation between height and weight, wherein lighting of lamps indicates legibly and clearly whether the weight of a weighed person is optimum for his or her height.

The second object of the invention is to provide a weighing machine adapted to indicate through said lighting of lamps whether an actual weight of the weighed person is optimum or not and at the same time to indicate a degree of over or under weight according to the position of the particular lamp which is lit.

The third object of the invention is to provide the weighing machine as mentioned above wherein the lamps are of different colors for easy and clear indication.

The fourth object of the invention is to provide the weighing machine as mentioned above wherein in a scale plate bearing a height scale is provided separately of the weight scale plate so that each of many weighed persons may individually adjust the height scale plate to his or her own height in individual weighing.

The fifth and final object of the invention is to make the appearance of the machine more attractive and to interest the user through lighting of lamps.

The other objects of the invention will be understood from reading the detailed description of the specification with reference to the annexed drawing.

According to the present invention, these objects are achieved by a plurality of lamps symmetrically arranged on one side of the platform relative to a center lamp which indicates the optimum value, the height scale plate or ring rotatably mounted in concentric relation with the weight scale plate so as to be manually positioned, a plurality of slidable contact plates on this height scale plate being connected to said lamps, respectively, and a movable contact secured to the weight scale plate being brought into contact with said slidable contact plates so as to light the corresponding lamp. Approximate amount of over or under weight in comparison with the optimum value can be recognized at a glance according to the position of a lamp which is lit relative to the center lamp indicating the optimum value by limiting the effective contact range of each slidable contact plate to a predetermined amount of the weight scale plate, for example, to 5 kg.

BRIEF DESCRIPTION OF DRAWINGS

A preferred embodiment of the weighing machine according to the present invention will be shown by the annexed drawing in which:

FIG. 1 is a perspective view of the weighing machine according to the invention;

FIG. 2 is an enlarged plan view of an important part of the weighing machine as shown by FIG. 1, illustrating the relation between a height scale ring and a weight scale disc; and

FIG. 3 is a circuit diagram in the weighing machine according to the invention.

DESCRIPTION OF PREFERRED EMBODIMENT

In a preferred embodiment as shown by FIGS. 1 to 3, a platform 11 on which an individual stands has a window 12 through which scales are read and is carried through a weighing mechanism on a base 13. The weighing mechanism may be that of prior art wherein the platform is supported on four arms which are, in turn, supported by respective coil springs, or is supported by two plate-like frames. The platform 11 is provided at its front end with a casing 14 projecting therefrom and this casing 14 has a blue lamp 15 arranged on the center of upper surface thereof, and two yellow lamps 16, 16 and two red lamps 17, 17 which are symmetrically arranged with predetermined distances from said blue lamp 15. The casing 14 is additionally provided on lower portion thereof with a battery casing 18. The blue, yellow and red lamps 15, 16 and 17 are respectively connected at their poles on one side to slidable contact plates 20, 21 and 22 of a height scale plate or ring 24 as will be described below (as shown by FIG. 3), and at their poles on other side to a battery 31. A weight scale disc 23 is arranged so as to be rotated together with a shaft 32 by the weighing mechanism (not shown) and to indicate a weight value through a weight scale 30 thereon and an indicator 29. The height scale ring 24 is arranged closely around the periphery of said weight scale disc 23 so as to be rotatable around the shaft 32 and bears a height scale 28 opposed to the weight scale 30 on the weight scale disc 23. The height scale ring 24 is provided on its periphery with teeth 27 meshing with a gear 26 which is integral with a knob 25 projecting from upper surface of the platform 11 through an opening therein. A movable contact 19 is secured on the under side of the weight scale disc 23 in the path of movement of the slidable contact plates 20, 21 and 22 which are secured on the height scale plates 24 so as to be rotatable together therewith as already described. An end 19' of the movable contact 19 which is bent and elastic is adapted to engage said slidable contact plates 20, 21 and 22 with an almost negligible friction as the weight scale disc 23 rotates.

Now a consideration should be taken for so-called optimum proportion between height and weight of a human body before the use of the weighing machine according to the invention is described. For the average Japanese, the optimum proportion is usually given by a relation, as follows:

(height given in cm − 100) × 0.9 = weight given in kg.

Such a relation may more or less depend on some factors such as races and states of particular countries. For Japanese, the relation indicates that the height of 160 cm preferably corresponds to the weight of 54 kg. The weighing machine according to the invention has the height scale 28 and the weight scale 30 on the scale ring 24 and the scale disc 23, respectively, in conformity with the conversion rate as given by the above relation. Lengths of the slidable contact plates 20, 21 and 22 correspond to the range of the weight scale 30 extending over ± 5 kg. so that, the blue lamp 15 is lit in the range of the optimum weight value ± 5 kg for a particular height value, indicating the particular weight value being substantially in the optimum range for the particular height value, the yellow lamps 16 16 are lit in the range of ± 5 kg to ± 10 kg from the optimum weight value, and the red lamps 17, 17 are lit in the range beyond ± 10 kg from the optimum weight value.

A person using the scale rotates the knob 25 until his or her own height on the height scale ring 24 is accurately aligned with the indicator 29 before weighing. Such a coordination also accomplishes movement of the slidable contact plates 20, 21 and 22. When an individual places his or her own weight on the platform 11, the scale disc 23 is rotated by an amount in proportion to the weight and indicates the weight value at the position of the indicator 29. Simultaneously the movable contact 19 is rotated together with the weight scale disc 23 and the end 19' thereof comes into contact with the slidable contact plate 20, 21 or 22 whereby the corresponding lamps are lit. In case of the optimum weight for a particular height said movable contact 19 is brought into contact with the slidable contact plate 20 and the blue lamp 15 is continuously lit. In case of the optimum weight value ± 5 kg, one of the yellow lamps 16, 16 symmetrically arranged with respect to the blue lamp 15 is lit. If the loaded scale disc 23 rotates in a counter-clockwise direction as viewed in FIG. 2, the left one of the yellow lamps 16, 16 is lit indicating over weight and the right one of the yellow lamps 16, 16 is lit indicating under weight. This is similar for the red lamps 17, 17. The range of comparatively indicating the weight and the height may be optionally selected by changing the contact range of each slidable contact plate 20, 21 and 22 in correspondence with the range of the weight scale disc 23.

With the weighing machine of the invention, as aforementioned, the weighed person may directly recognize the relationship between his or her weight and an ideal weight according to the particular lamp being lit all that is required is the preliminary operation of merely positioning the height scale plate according to his or her own height value.

Thus, according to the invention the weighing machine includes a height-indicating means which is adjustable to indicate the height of a given individual, a weighing means for indicating the weight of the individual, and an indicating means operatively connected with the height-indicating means and the weighing means and including a plurality of lamps one of which is lit when the weighing means indicates the weight of the individual for indicating by the lamp which is lit the relationship between the actual weight of the individual and his ideal weight.

What is claimed is:

1. A weighing machine comprising height-indicating means for indicating the height of a person using the weighing machine, weighing means for weighing a person, and relationship-indicating means operatively connected with said height-indicating means and said weighing means and including a plurality of lamps adapted to be lit according to the relative position between said height-indicating means and weighing means for indicating the relationship between the actual weight of an individual and his ideal weight.

2. A weighing machine according to claim 1, wherein said height-indicating means for indication of height is adjustable in coordination with a particular height of the weighed person.

3. A weighing machine according to claim 2, wherein a plurality of said lamps are arranged in a line and one of said lamps is lit according to a particular value given by the weighing means.

4. A weighing machine according to claim 2, wherein the height-indicating means comprises a height scale plate adapted to be rotated in concentric relation with a weight scale plate.

5. A weighing machine according to claim 3, wherein said plurality of lamps include a center lamp and are associated with said height-indicating means and are adapted to indicate any over or under weight relative to an optimum weight value for the particular height value depending upon the position of the lamp which is lit relative to the center lamp.

6. A weighing machine according to claim 4, wherein the height scale plate is provided with slidable contact plates in a line electrically connected with said plurality of lamps, respectively, and the weight scale plate is provided with a movable contact opposed to said slidable contact plates.

7. The combination of claim 1 and wherein an adjusting means is operatively connected with said height-indicating means for adjusting the latter according to the height of the person using the weighing machine, said relationship-indicating means including a series of first contacts respectively connected electrically with said lamps, and said weighing means including a second contact which moves with said weighing means when the latter indicates the weight of a person using the weighing machine, said first contacts being arranged in a row along the path of movement of said second contact so that a given one of said first contacts will be engaged by said second contact to illuminate one of said lamps for indicating the relationship between the weight of a person using the weighing machine and his ideal weight.

8. The combination of claim 7 and wherein said lamps include a central lamp and a plurality of additional lamps arranged before and after said central lamps symmetrically with respect thereto while said series of first contacts include a center first contact operatively connected with said central lamp, whereby the particular lamp which is illuminated will indicate said relationship according to its position with respect to the center lamp, the latter lamp indicating the ideal weight.

9. The combination of claim 8 and wherein said series of first contacts respectively have a length which will provide for illumination of one of said lamps within a given weight range.

* * * * *

United States Patent [19]
Baumgartner

[11] 3,826,318
[45] July 30, 1974

[54] DIGITAL WEIGHING SCALE WITH AN INCREMENTAL MEASURING SYSTEM

[75] Inventor: Alfons Baumgartner, Grassau, Germany

[73] Assignee: Dr. Johannes Heindenhain, Trannreut, Germany

[22] Filed: June 22, 1972

[21] Appl. No.: 265,308

[30] Foreign Application Priority Data

June 22, 1971 Germany 2130840

[52] U.S. Cl. 177/25, 177/1, 177/3, 177/50, 177/DIG. 3, 177/DIG. 6, 235/151.33

[51] Int. Cl. G01g 23/10, G01g 23/365

[58] Field of Search .... 177/1, 3, 25, 50, DIG. 1, 177/DIG. 3, DIG. 6; 235/151.33

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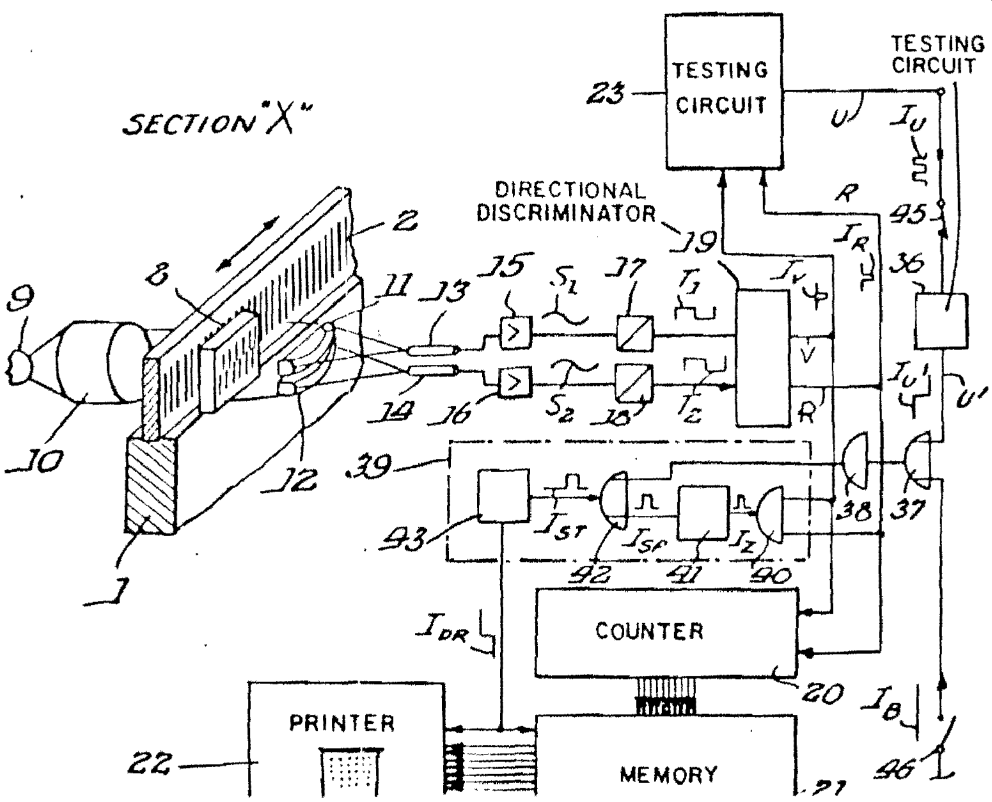
Primary Examiner—Stephen J. Tomsky
Assistant Examiner—Vit W. Miska
Attorney, Agent, or Firm—Granger Cook, Jr.; Jerold A. Jacover

[57] ABSTRACT

A digital scale having an incremental measuring system is disclosed. The scale includes a source of light, a weight-indicating movable grid and a stationary grid all in optical alignment, the two grids having alternately disposed transparent and nontransparent vertical surfaces, wherein the upper portions of said surfaces on the stationary grid are slightly offset from the lower portions thereof. Photoelectric means produce a series of leading and lagging electrical signals when the movable grid moves in response to a load placed on the scale, the signals from the upper portions of the stationary grid leading when the weight indicated by the movable grid is increasing, and the signals from the lower portions leading when the weight is decreasing. An electrical discriminator discerns which signals are leading, and converts them to electrical impulses which are passed to a count-up—countdown counter for recording the weight. Testing circuitry, which determines when the scale is substantially still, produces electrical information for energizing digital means, connected to the counter at that time. During substantial movement of the scale, however, the testing circuit prevents the digital means from being energized, thereby assuring weight readings only when the scale is substantially still.

8 Claims, 4 Drawing Figures



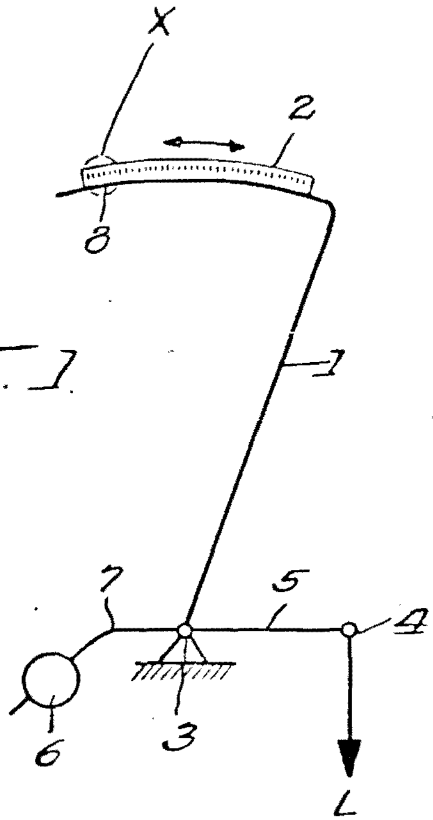
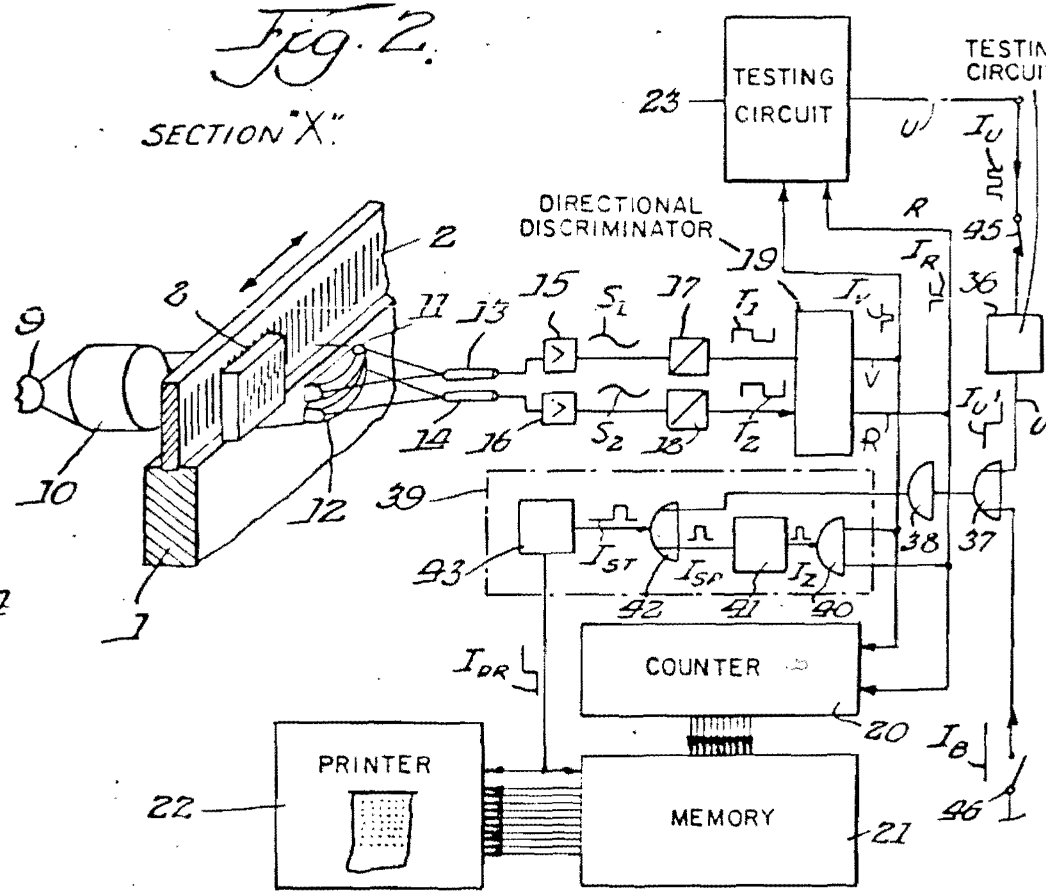


Fig. 1

Fig. 2.

SECTION "X".



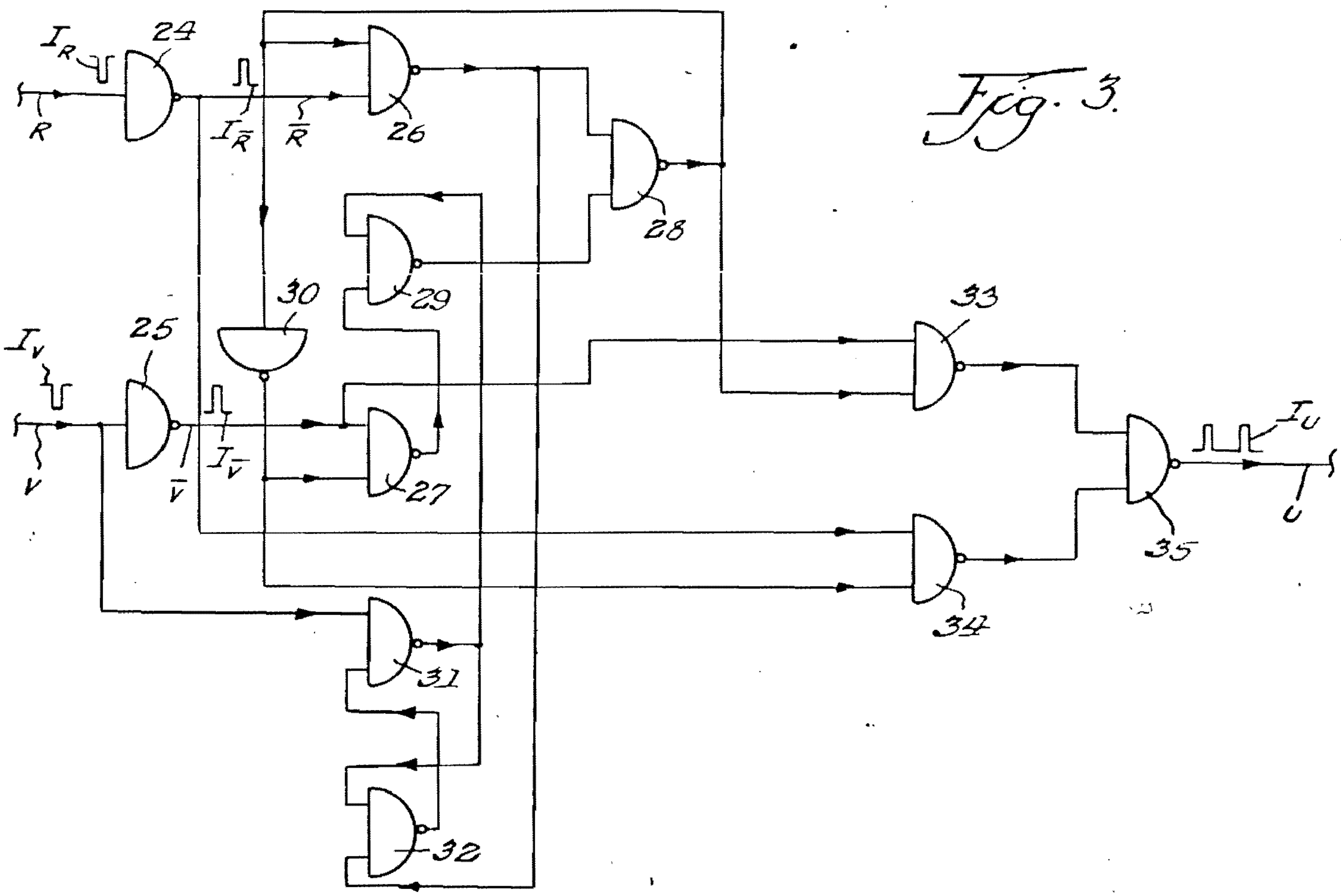

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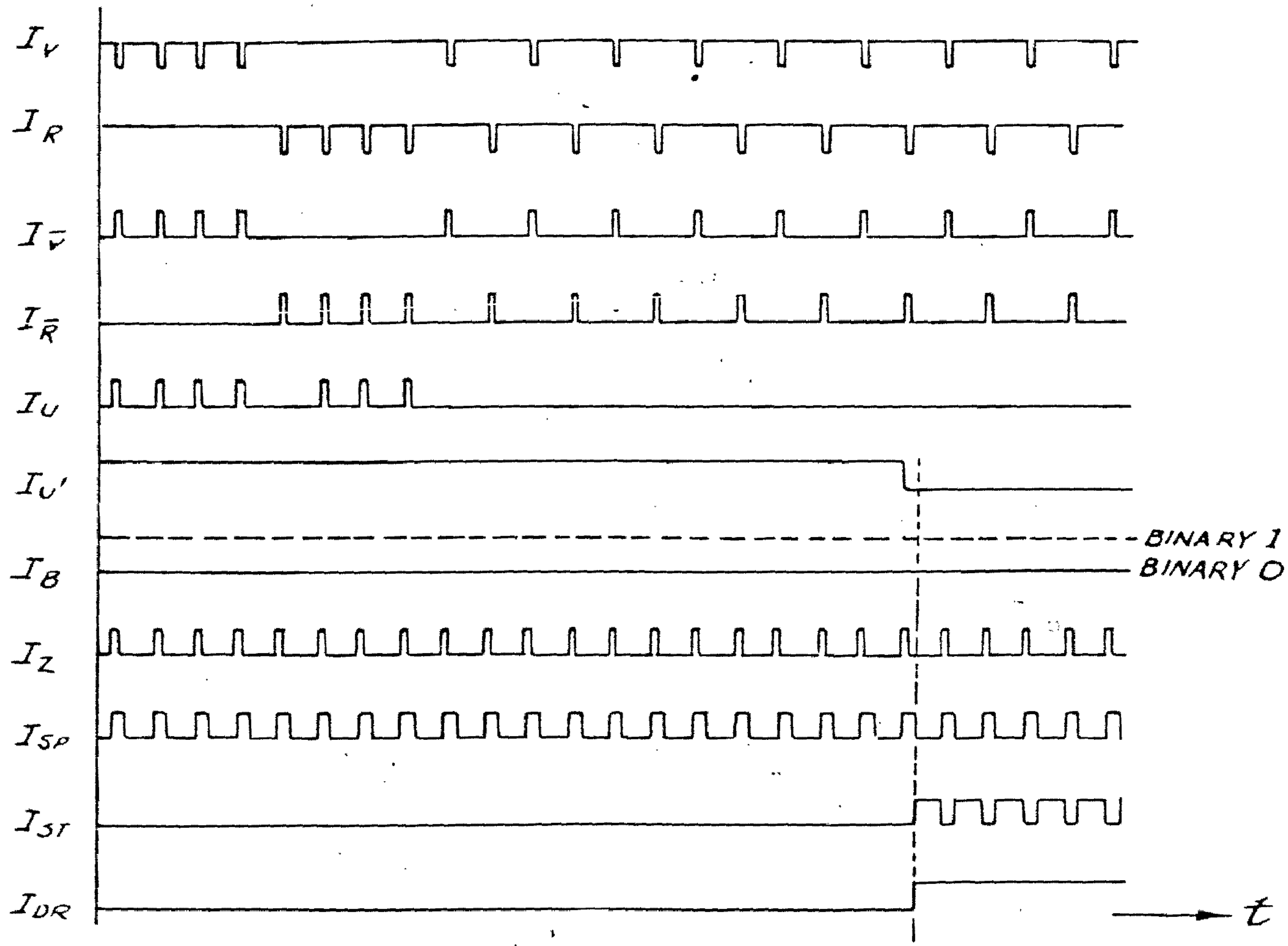
Fig. 3.

Fig. 4



DIGITAL WEIGHING SCALE WITH AN INCREMENTAL MEASURING SYSTEM

This invention relates to a scale with an incremental measuring system which delivers in function of weight, a corresponding number of impulses via a directional discriminator to a count-up—countdown counter.

The value of the weight to be determined may be printed out at a digital printer, for example, or be processed further in a comparator.

According to prior art, scales without a digital electrical measuring system comprises an electrical stop indicator apparatus. In these scales, a slotted or foraminous disk, or the like, is connected to the scale pendulum and scanned by stationarily mounted photo elements. The presence or absence of electrical signals is thereby a criterion for determining whether or not the scale is oscillating. Scales of this kind either operate inexactly, because no definite recording of the weight values is possible due to the vibrations to which a load placed on the scale is subjected, or they operate through means of an electrical analogous technique, so that they are inappropriate for digital electrical measuring systems.

In contrast thereto, the present invention makes possible, in a scale with an incremental measuring system, a clear issuance or reading of posted weight values, without alternating in the borderline position between two consecutive readings.

The present invention solves the problem posed in a scale with an incremental measuring system of the kind initially described, in that the impulse sequences at the output of the directional discriminator are also enlisted as a criterion to determine when the scale is oscillating and when it is substantially still.

In the scale according to the invention, a circuit is provided which signals the moment an electrical impulse appears at either one of two outputs of the directional discriminator, but only when that electrical impulse is preceded by a predetermined number of electrical impulses at the same output without interruption by electrical impulses from the other output. If an electrical impulse is not preceded by said predetermined number, electrical information will be generated after a certain span of time t following this moment, indicating that the scale is substantially still. This time delay t thus permits the electrical information to be generated only when scale oscillations of substantially small amplitudes occur.

It is a primary object of this invention to provide an improved digital scale having an incremental measuring system.

It is another object of this invention to provide, in a digital scale having an incremental measuring system, electronic means for determining when the scale is subject to oscillations of substantially small amplitudes.

Other objects, features and advantages will be apparent upon reading the following detailed description of the invention in conjunction with the accompanying drawings.

FIG. 1 schematically shows a scale to which the invention shall be applied;

FIG. 2 shows an enlargement of a cutout X of FIG. 1 along with the circuit arrangement according to the invention;

FIG. 3 shows a testing circuit for FIG. 2;

FIG. 4 is a signal sequence table relating to FIGS. 2 and 3.

FIG. 1 schematically represents an inclination scale. A grid graduation 2 not linearly graduated of an incremental measuring system is provided at the inclination lever 1. As a result of the nonlinear grid graduation 2 a proportionality is established between the deflection of the inclination lever 1 and the load L. The inclination lever 1 is pivotable via a blade bearing 3. The load L acts via a blade or knife edge bearing 4 upon the load arm 5. A counterweight 6 at arm 7 provides the resetting force.

FIG. 2 shows the entire luminous-electrical grid scanning system. The grid graduation 2 is scanned by a stationarily mounted grid scanning plate 8. Grids 2 and 8 are provided with alternately transparent and nontransparent vertical surface areas. The upper surface areas of scanning plate 8 are offset or staggered from the lower surface areas thereof by approximately one-fourth of the distance between the transparent and nontransparent surface areas. Grids 2 and 8 are illuminated by a lamp 9 via a condenser 10. Upper objective 11 and lower objective 12 concentrate the clusters of light passing across the scanning plate 8 upon the photo elements 13 and 14, respectively. Because the upper surface areas of grid 8 are offset from the lower areas thereof, however, the clusters of light passing through upper objective 11 leads the clusters of light passing through lower objective 12.

The electrical output signals of the photo elements 13 and 14 are reinforced in amplifiers 15 and 16. The amplified signals S_1 and S_2 are converted in Schmitt triggers 17 and 18 into rectangular signal T_1, characterized as leading, and a rectangular signal T_2, characterized as lagging, when inclination lever 1 is registering increasing weight in response to the application of load L on knife edge bearing 4. When inclination lever 1 overshoots the weight of load L, and begins compensating therefor by registering a decreasing weight, signal T_1 becomes lagging and signal T_2 becomes leading. The rectangular signals T_1 and T_2 are passed to a conventional directional disciminator 19, which discerns which of signals T_1 and T_2 are leading and lagging through the well-known technique for measuring lengths or angles by reversible counting of pulses. Upon receipt of signals T_1 and T_2, directional discriminator 19 produces impulses at output V if signal T_1 is leading, and at output R id signal T_2 is leading. Output V is connected to the forward input of an electric count-up — countdown counter 20, output R is connected to the reverse input of electronic count-up — countdown counter 20. Count-up — countdown counter 20 controls, via a member 21, a building unit 22 which, in the preferred embodiment, is a digital printer.

The impulses I_V and I_R at outputs V and R of directional discriminator 19 are fed into a testing circuit 23. Testing circuit 23 has an output V which signals at the moment an impulse appears at output V or R of directional discriminator 19, but only if that impulse which is preceded by a predetermined number of electrical impulses from the same output, without interruption by electrical impulses from the other output. If an electrical impulse is not preceded by said predetermined number, the output of testing circuit 23 will remain at a minimal level, indicating the scale is subject to oscillations of substantially small amplitude, and is therefor substantially still. FIG. 3 shows a possible logical circuit for carrying out said test in which testing circuit 23 produces an output impulse after two consecutive electrical impulses have been received from the same output of discriminator 19. The testing circuit accord ng to FIG. 3 is accommodated in the circuitry shown in FIG. 2.

The impulses I_V and I_R arrive at testing circuit 23 via inversion members 25 and 24. The outlet $\bar{R}$ of the member 24 is placed at a NAND gate 26, and outlet $\bar{V}$ of member 25 is placed at a NAND gate 27. The outlet of a NAND gate 28 is connected to the other input of the NAND gate 26. The output of the NAND gate 26 and 29 is placed at the inputs of the NAND gate 28. An inversion member 30 also is provided at the output of the NAND gate 28, the output of said member 30 being placed at the other input of the NAND gate 27. The output of the NAND gate 27 is connected to one input of the NAND gate 29.

The outlet V of the directional discriminator 19 is placed at a NAND gate 31, whose other input is connected to the output of a NAND gate 32. The outlet of NAND gate 31 and the outlet of NAND gate 26 are placed at the inputs of the NAND gate 32. The output of the NAND gate 31 is connected furthermore to the second input of the NAND gate 29. The outlet V of the inversion member 25 and the output of the NAND gate 28 are also connected to an NAND gate 33, whose output together with the output of a NAND gate 34 is placed to an additional NAND gate 35. The outlet of the inversion members 24 and 30 are connected to the inputs of the NAND gate 34.

The outlet U of the NAND gate 35 is connected to a timing member 36 (FIG. 2) which may be a monostable sweep phase. The time constant t of the timing member 36 is tuned according to the mechanical attenuation of the scale. Timing member 36 has an output U' which, as indicated by signal $I_{U'}$ in FIG. 4, is generally at a binary 1 condition. However, when signal I_U from testing circuit 23 is at a minimal level, and has remained at said level for a predetermined period of time indicating the scale is substantially still, timing member 36 will switch to a binary 0 condition. This electrical information is used to commence digital weight readout in a manner explained in greater detail hereinafter.

The functional table for the testing circuit according to FIG. 3 reads as follows in the time sequence for the impulse IV and I_R shown in FIG. 4:

$I_{\bar{V}}$	$I_{\bar{R}}$	I_U	$I_{U'}$
0	0	0	1
1	0	1	1
0	0	0	1
1	0	1	1
0	0	0	1
1	0	1	1
0	0	0	1
1	0	1	1
0	0	0	1
0	1	0	1
0	0	0	1
0	1	1	1
0	0	0	1
0	1	1	1
0	0	0	1
0	1	1	1
0	0	0	1
1	0	0	1
0	0	0	1
0	1	0	1
0	0	0	1
1	0	0	1

-Continued

$I_{\bar{V}}$	$I_{\bar{R}}$	I_U	$I_{U'}$
0	0	0	1
0	1	0	1
0	0	0	1
1	0	0	1
0	0	0	1
0	1	0	1
0	0	0	1
1	0	0	1
0	0	0	1
0	1	0	1
0	0	0	1
1	0	0	1
0	0	0	1
0	1	0	1
0	0	0	1
1	0	0	1
0	0	0	1
0	1	0	0
0	0	0	0
1	0	0	0
0	0	0	0
0	1	0	0
0	0	0	0
1	0	0	0
0	0	0	0
0	1	0	0
0	0	0	0
1	0	0	0
0	0	0	0

The functional table shows that the testing circuit signals that the seal is substantially still when an alternating sequence of impulses I_V and I_R occurs within a substantially short period of time.

The output U' of the time member 36 is connected to the input of a NOR gate 37. At the other input of the NOR gate 37 the impulses of a command transmitter 46 become effective. The outlet of the NOR gate 37 is placed at an inversion member 38 whose output is connected together with the outlet V and R of the directional discriminator 19 to a construction unit 39. The construction unit 39 causes the take-over of the reading to be prevented for a short time in each case at the jumping points of the scanning signals T_1 and T_2. The construction unit 39 moreover causes the memory 21 to be held firmly in each case when readings are called, until the take-over of the message is concluded in the reading value printer 22. The interval during which the transfer of the reading is interrupted for a short time at the signal jump is tuned to electrical passage times in the counter 20 and in the memory 21.

The building unit 39 comprises a NAND gate 40, with outputs V and R of the directional discriminator 19 being connected to its inputs. The NAND gate 40 delivers in each case at the jumping points of signals T_1 and T_2 impulses I_Z (FIG. 4) to a time member 41. The time constant of the time member 41 is tuned to electrical passage times in the counter 20 and in the memory 21. The time member 41, which may be a monostable sweep phase, controls a NOR gate 42, the output of an inversion member 38 adhering to its other input. If the impulse I_U' at the output U' of the time member 36 jumps from binary 1 to binary 0, and if the impulse I_{SP} (FIG. 4) also changes at the output of the time member 41 from binary 1 to binary 0, a change of condition from binary 0 to binary 1 occurs at the output of the NOR gate 42. The impulse I_{ST} present (FIG. 4) at the output of NOR gate 42 sets another time member 43 which may also be a monostable sweep phase. The time constant of the time member 43 is tuned to the time span the printer 22 of the readings needs for complete transfer of messages from memory 21. An impulse I_{DR}

at the outlet of the time member 43 thus causes the memory 21 to be held firmly until the printer 22 has completed the taking over of the reading. At the same time the readiness for taking over the reading is established during the condition change from binary 0 to binary 1 at the output of the time member 43 in the printer 22.

The testing unit 23 controlling the oscillating of the scale can be put out of operation by opening a switch 45 mounted in the conduit branch U. It is possible to prevent the printing out of weighing results by closing the switch 46.

I claim:

1. A digital scale comprising:

incremental measuring means, for indicating the weight of a load placed on said scale, subject to oscillations of varying amplitudes about the weight of said load;

signal generation means having a first terminal producing a series of first-characterized signals and a second terminal producing a series of second-characterized signals when said incremental measuring means are indicating increasing weight; said first terminal producing a series of said second-characterized signals and said second terminal producing a series of said first-characterized signals when said incremental measuring means are indicating decreasing weight;

discrimination means, having a first output and a second output, for distinguishing said first-characterized signals from said second-characterized signals, and for producing a corresponding series of electrical impulses at said first output upon receipt of said first-characterized signals from said first terminal, and producing a corresponding series of electrical impulses at said second output upon receipt of said first-characterized signals from said second terminal; the duration in which electrical impulses are alternately produced at said first and second outputs corresponding to the amplitude of said oscillations of said incremental mesuring means;

counting means, adding the electrical impulses received from said first output and subtracting the electrical impulses received from said second output, to register the weight of said load;

digital means, coupled to said counting means, for representing the weight of said load in digital form upon energization of said digital means, and

testing means, coupled to said discrimination means, for determining the duration in which electrical impulses are alternately produced at said first output and said second output; said testing means producing electrical information to energize said digital means when said duration is substantially small, whereby said digital means are energized only when said incremental measuring means are subject to substantially small oscillations.

2. The digital scale receited in claim 1 wherein said incremental measuring means include a movable grid and a stationary grid, each having alternating transparent and nontransparent vertical surface areas, the upper portion of said vertical surface areas of said stationary grid being offset relative to the lower portion of said vertical surface areas of said stationary grid.

3. The digital scale recited in claim 2 wherein said signal generation means include a source of light aligned behind said movable grid and said stationary grid, producing a leading light signal when said light is passed through the transparent upper portions of said stationary grid and a lagging light signal when said light is passed through the transparent lower portions of said stationary grid when said incremental measuring means indicate increasing weight; said source of light producing a lagging light signal when said light is passed through the transparent upper portions of said stationary grid and a leading light signal when said light is passed through the transparent lower portions of said stationary grid when said incremental measuring means indicate decreasing weight.

4. The digital scale recited in claim 3 wherein said signal generation means further include photoconductor means for respectively converting said leading and lagging light signals into a series of leading electrical pulses and a series of lagging electrical pulses.

5. The digital scale recited in claim 1 wherein said testing means include electronic logic for producing an output impulse when an electrical impulse received from one of said outputs of said discrimination means was immediately preceded by an electrical impulse from the same output; said logic circuit producing no output impulse when an electrical impulse received from one of said outputs of said discrimination means was not immediately preceded by an electrical impulse from the same output.

6. The digital scale recited in claim 5 wherein said testing circuit further includes delay means coupled to said electronic logic, normally displaying a first voltage state; said delay means switching to a second voltage state when no output impulse is received from said electronic logic for a predetermined time; said delay means energizing said digital means after switching to said second voltage state.

7. The digital scale recited in claim 5 wherein said predetermined time is greater than the time required to produce two of said electrical impulses by said discrimination means.

8. The digital scale recited in claim 1 further includes a construction unit coupled between said testing means and said digital means for delaying passage of said electrical information to said digital means until after any existing electrical impulse produced by said discrimination means is dissipated.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,826,318 Dated July 30, 1974

Inventor(s) Alfons Baumgartner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Assignee designation, the name "Trannreut" should be spelled --Traunreut--.

Column 2, Line 34, after "T_2" change "." to --,--.

Line 48, change "id" to --if--.

Column 3, Line 48, change "IV" to --$I_{\overline{V}}$-- and change "I_R" to --$I_{\overline{R}}$--.

Column 4, Line 28, change "I_V" to --$I_{\overline{V}}$-- and change "I_R" to --$I_{\overline{R}}$--.

Signed and sealed this 24th day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

United States Patent [19]
Williams, Jr. et al.

[11] 3,869,005
[45] Mar. 4, 1975

[54] VALUE COMPUTING SCALE

[75] Inventors: Roger B. Williams, Jr., Sylvania, Ohio; Richard C. Loshbough, Temperance, Mich.; Edward G. Pryor, Toledo, Ohio

[73] Assignee: Reliance Electric Company, Toledo, Ohio

[22] Filed: Apr. 17, 1974

[21] Appl. No.: 461,582

[52] U.S. Cl. 177/25, 177/165, 177/DIG. 1, 177/DIG. 3
[51] Int. Cl. G01g 23/22, G01g 23/14
[58] Field of Search .... 177/1, 25, 165, DIG. 1, 177/DIG. 3

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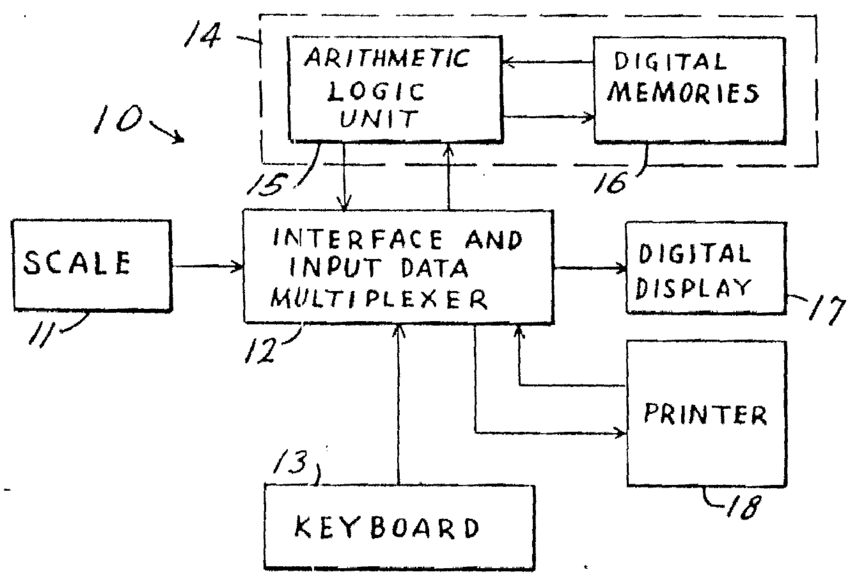
Primary Examiner—George H. Miller, Jr.
Attorney, Agent, or Firm—Thomas H. Grafton

[57] ABSTRACT

Improved apparatus for weighing and computing a value for articles. An integrated circuit microcomputer is supplied with the gross article weight from a scale and with price per unit weight data from a manual keyboard. Tare weight data may be entered either through the manual keyboard or automatically from the scale. The microcomputer computes a net weight and a value for each weighed article. The net weight, the price per unit weight and the value are indicated on a digital display and may be printed on a label. Filtering circuitry prevents jitter in the article weight supplied from the scale to the microcomputer and the display caused by small vibrations in the article or the scale.

4 Claims, 17 Drawing Figures



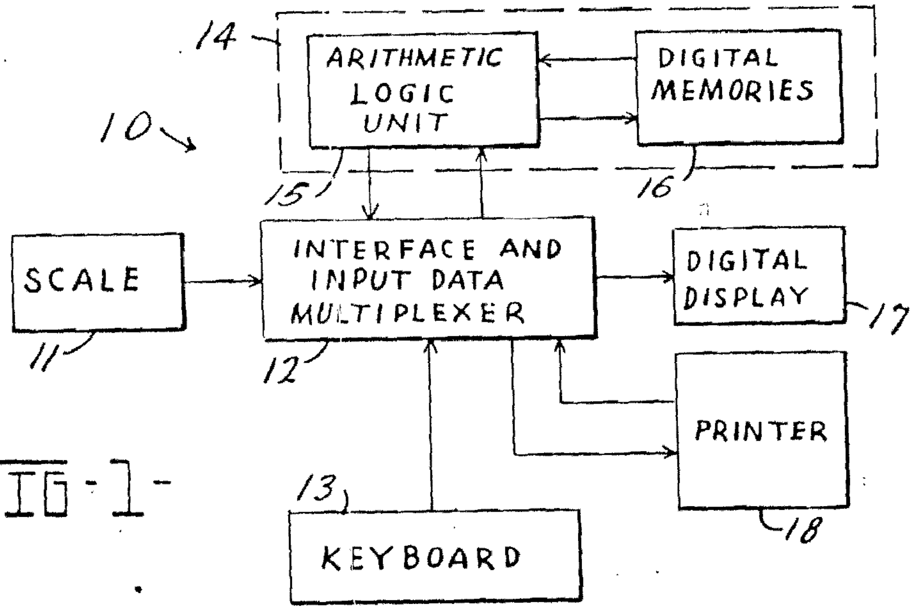

14
10
ARITHMETIC LOGIC UNIT
DIGITAL MEMORIES
15
16
SCALE
INTERFACE AND INPUT DATA MULTIPLEXER
DIGITAL DISPLAY
17
11
12
PRINTER
13
KEYBOARD
18

FIG-1-

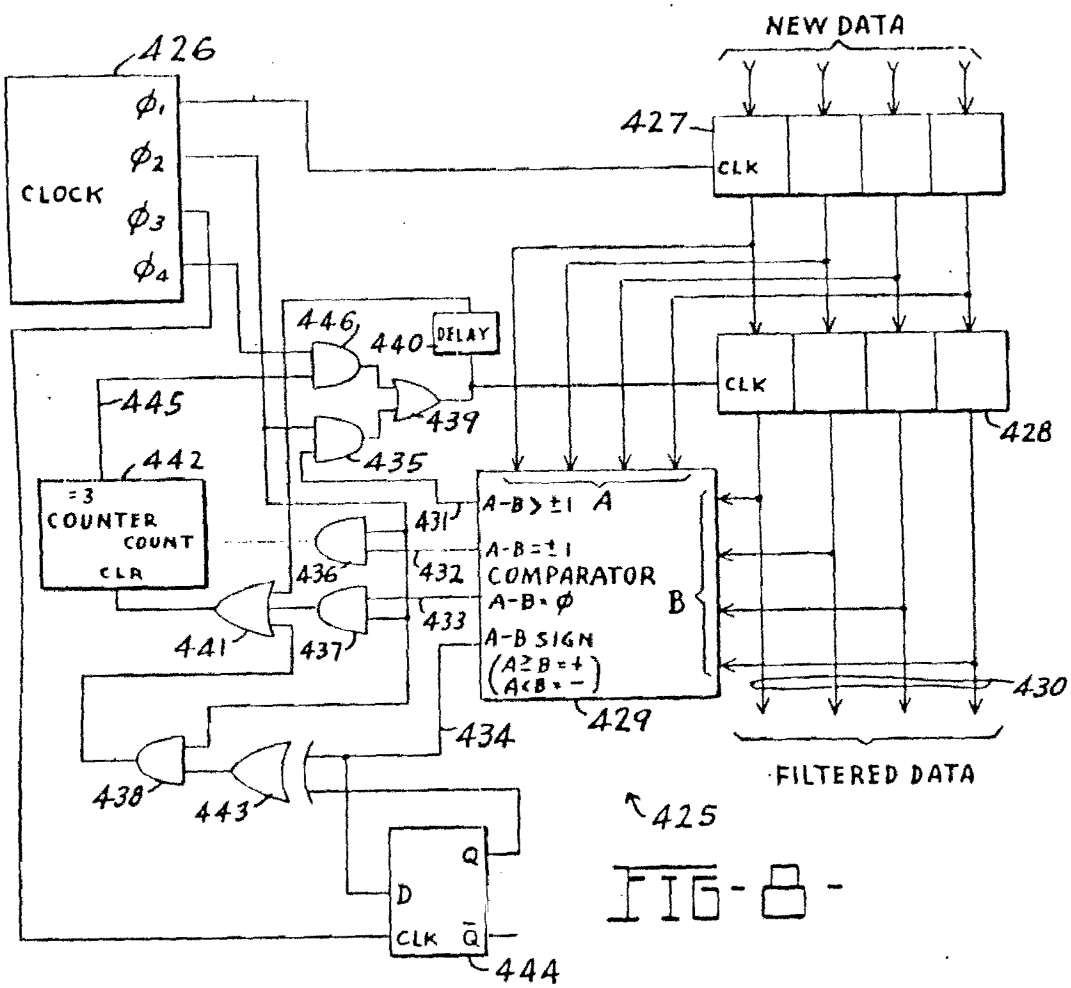

NEW DATA
426
CLOCK
ϕ_1
ϕ_2
ϕ_3
ϕ_4
427
CLK
CLK
428
446
440
DELAY
445
439
435
442
÷3 COUNTER
COUNT
CLR
431
A-B > ±1 A
A-B = ±1
432
COMPARATOR
A-B = ϕ
B
433
436
441
437
A-B SIGN
(A ≥ B = +
A < B = −)
429
430
434
FILTERED DATA
438
443
425
Q
D
CLK
$\bar{Q}$
444

FIG-8-

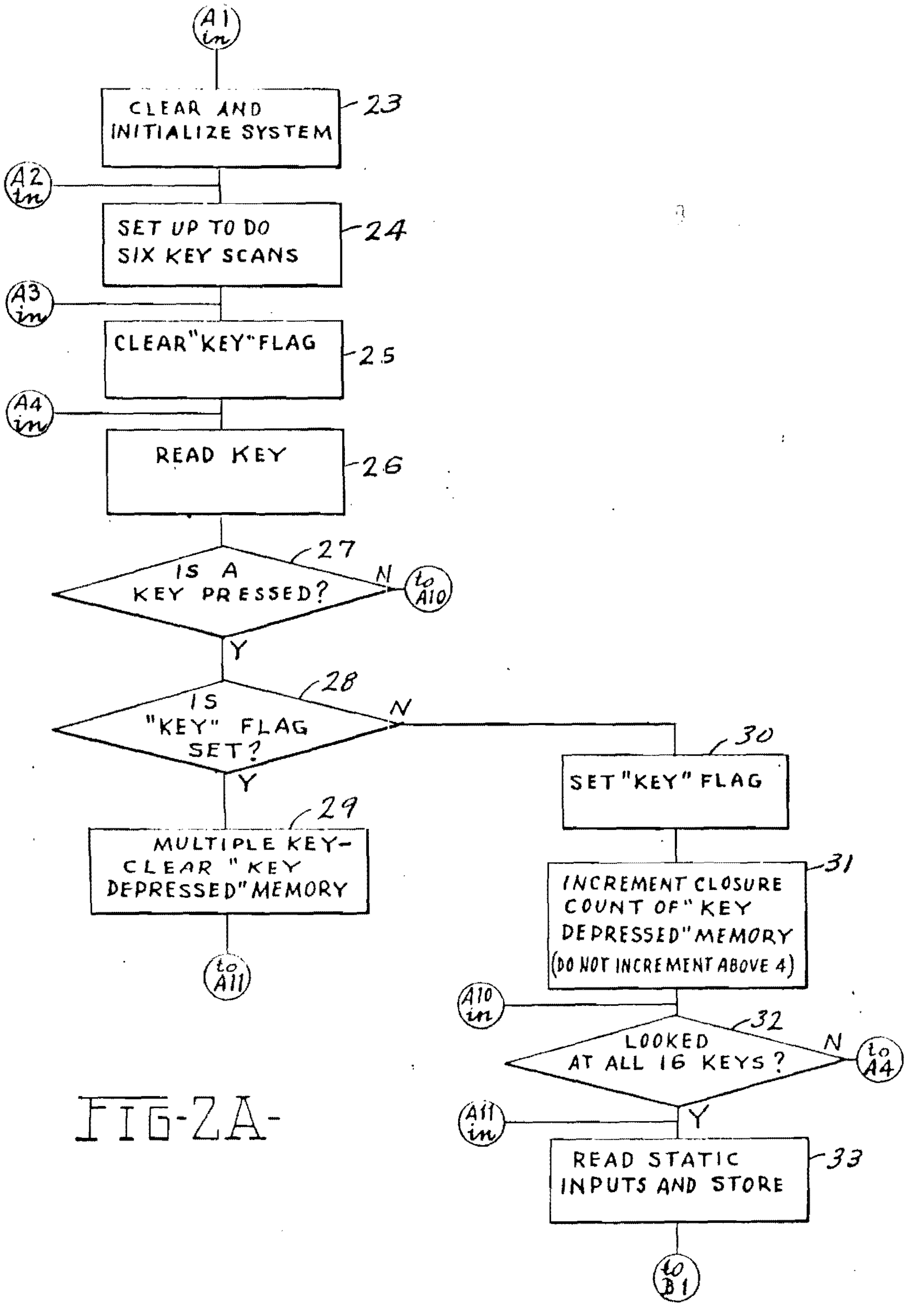

A1 in
CLEAR AND INITIALIZE SYSTEM
23
A2 in
SET UP TO DO SIX KEY SCANS
24
A3 in
CLEAR "KEY" FLAG
25
A4 in
READ KEY
26
IS A KEY PRESSED?
27
N
to A10
Y
IS "KEY" FLAG SET?
28
N
Y
MULTIPLE KEY- CLEAR "KEY DEPRESSED" MEMORY
29
to A11
SET "KEY" FLAG
30
INCREMENT CLOSURE COUNT OF "KEY DEPRESSED" MEMORY (DO NOT INCREMENT ABOVE 4)
31
A10 in
LOOKED AT ALL 16 KEYS?
32
N
to A4
Y
A11 in
READ STATIC INPUTS AND STORE
33
to B1

FIG-2A-

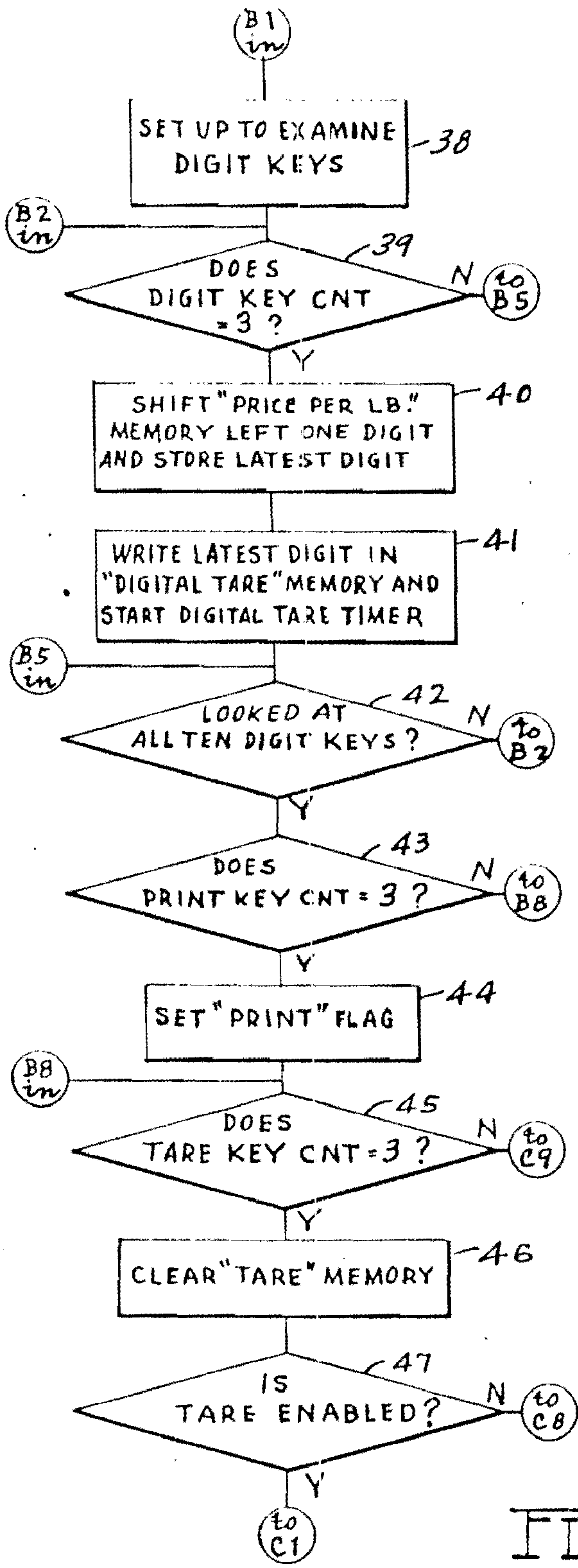

B1 in
SET UP TO EXAMINE DIGIT KEYS
38
B2 in
39
DOES DIGIT KEY CNT =3 ?
N
to B5
Y
SHIFT "PRICE PER LB." MEMORY LEFT ONE DIGIT AND STORE LATEST DIGIT
40
WRITE LATEST DIGIT IN "DIGITAL TARE" MEMORY AND START DIGITAL TARE TIMER
41
B5 in
42
LOOKED AT ALL TEN DIGIT KEYS ?
N
to B2
Y
43
DOES PRINT KEY CNT = 3 ?
N
to B8
Y
SET "PRINT" FLAG
44
B8 in
45
DOES TARE KEY CNT = 3 ?
N
to C9
Y
CLEAR "TARE" MEMORY
46
47
IS TARE ENABLED?
N
to C8
Y
to C1

FIG-2B-

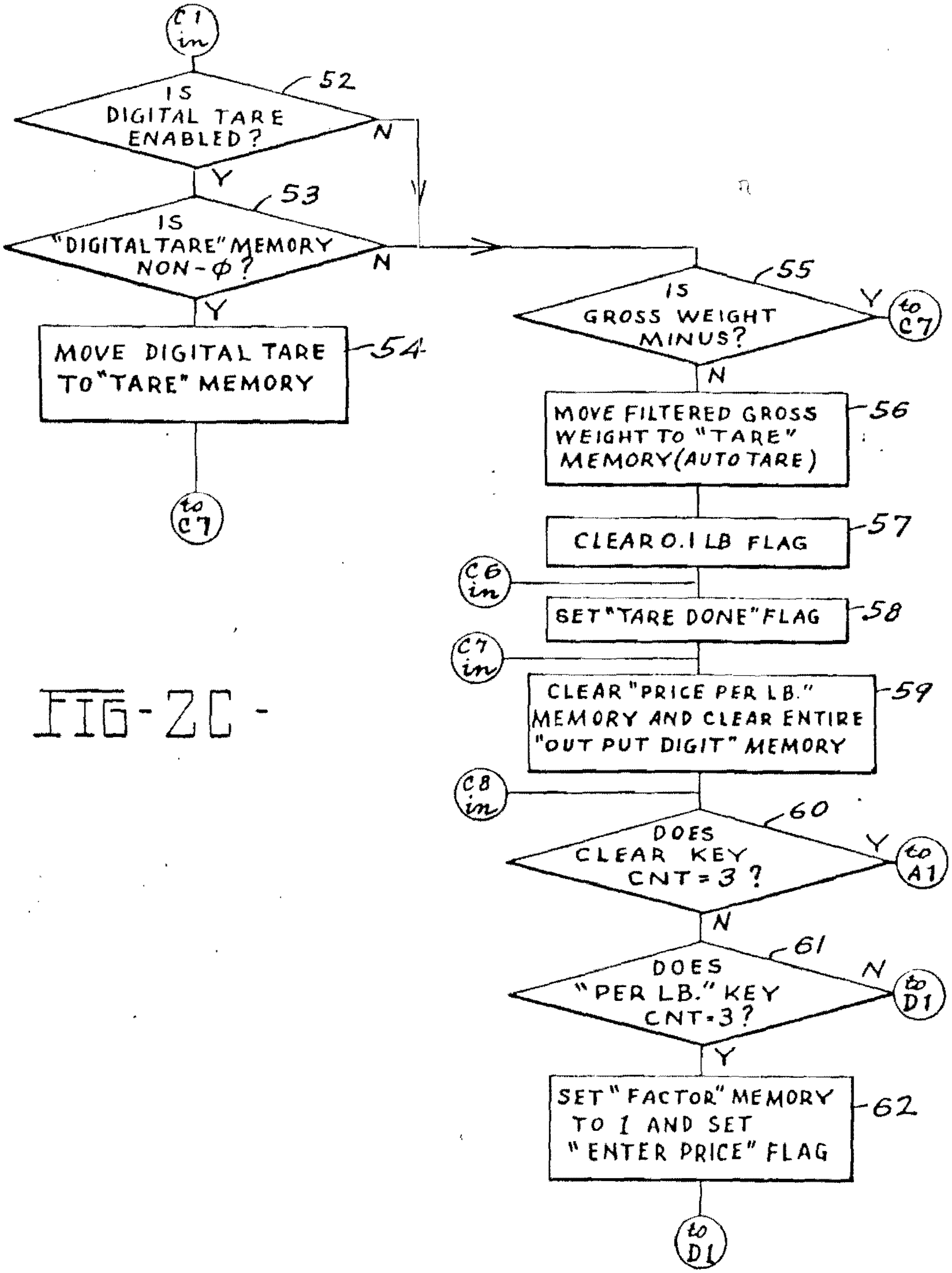

C1 in
IS DIGITAL TARE ENABLED?
52
N
Y
IS "DIGITAL TARE" MEMORY NON-φ?
53
N
Y
MOVE DIGITAL TARE TO "TARE" MEMORY
54
to C7
IS GROSS WEIGHT MINUS?
55
Y
to C7
N
MOVE FILTERED GROSS WEIGHT TO "TARE" MEMORY (AUTO TARE)
56
CLEAR 0.1 LB FLAG
57
C6 in
SET "TARE DONE" FLAG
58
C7 in
CLEAR "PRICE PER LB." MEMORY AND CLEAR ENTIRE "OUT PUT DIGIT" MEMORY
59
C8 in
DOES CLEAR KEY CNT = 3 ?
60
Y
to A1
N
DOES "PER LB." KEY CNT = 3?
61
N
to D1
Y
SET "FACTOR" MEMORY TO 1 AND SET "ENTER PRICE" FLAG
62
to D1

FIG-2C-

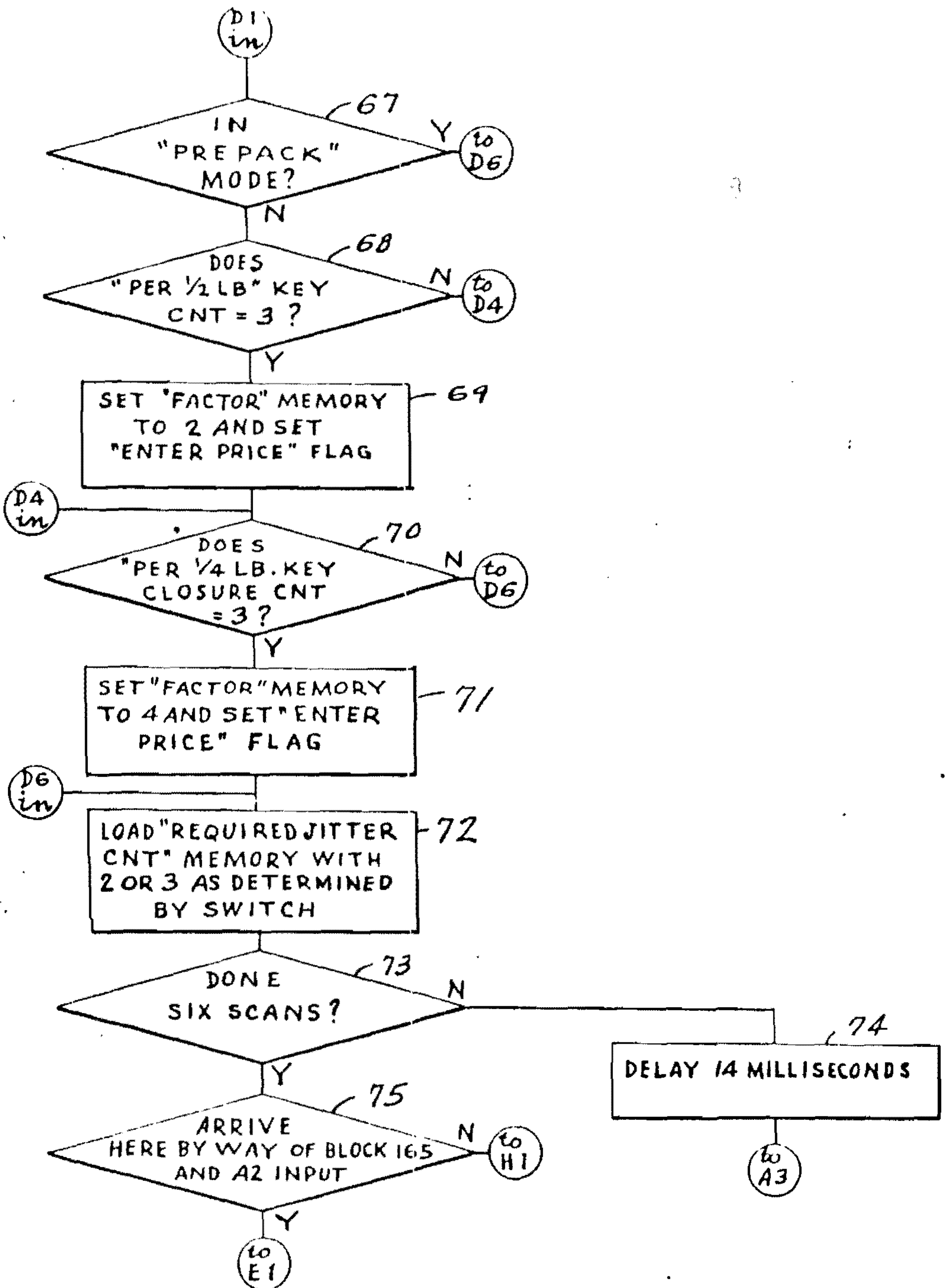

D1 in
67
IN "PREPACK" MODE?
Y
to D6
N
68
DOES "PER ½ LB" KEY CNT = 3 ?
N
to D4
Y
SET "FACTOR" MEMORY TO 2 AND SET "ENTER PRICE" FLAG
69
D4 in
70
DOES "PER ¼ LB. KEY CLOSURE CNT = 3 ?
N
to D6
Y
SET "FACTOR" MEMORY TO 4 AND SET "ENTER PRICE" FLAG
71
D6 in
LOAD "REQUIRED JITTER CNT" MEMORY WITH 2 OR 3 AS DETERMINED BY SWITCH
72
73
DONE SIX SCANS?
N
74
DELAY 14 MILLISECONDS
to A3
Y
75
ARRIVE HERE BY WAY OF BLOCK 165 AND A2 INPUT
N
to H1
Y
to E1

FIG-2D-

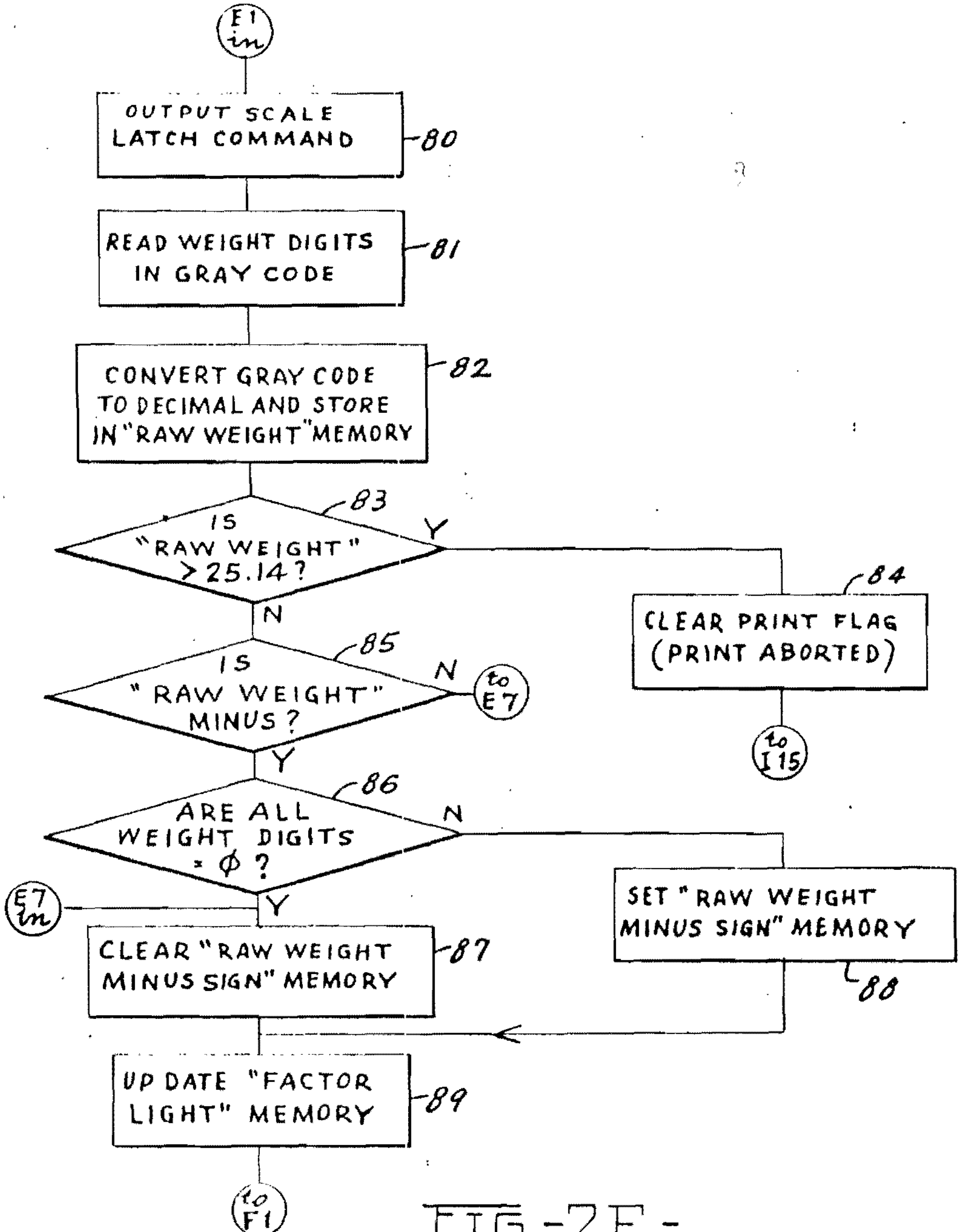

E1 in
OUTPUT SCALE LATCH COMMAND
80
READ WEIGHT DIGITS IN GRAY CODE
81
CONVERT GRAY CODE TO DECIMAL AND STORE IN "RAW WEIGHT" MEMORY
82
IS "RAW WEIGHT" > 25.14?
83
Y
N
CLEAR PRINT FLAG (PRINT ABORTED)
84
to I15
IS "RAW WEIGHT" MINUS?
85
N
to E7
Y
ARE ALL WEIGHT DIGITS = Ø ?
86
N
Y
E7 in
CLEAR "RAW WEIGHT MINUS SIGN" MEMORY
87
SET "RAW WEIGHT MINUS SIGN" MEMORY
88
UP DATE "FACTOR LIGHT" MEMORY
89
to F1

FIG-2E-

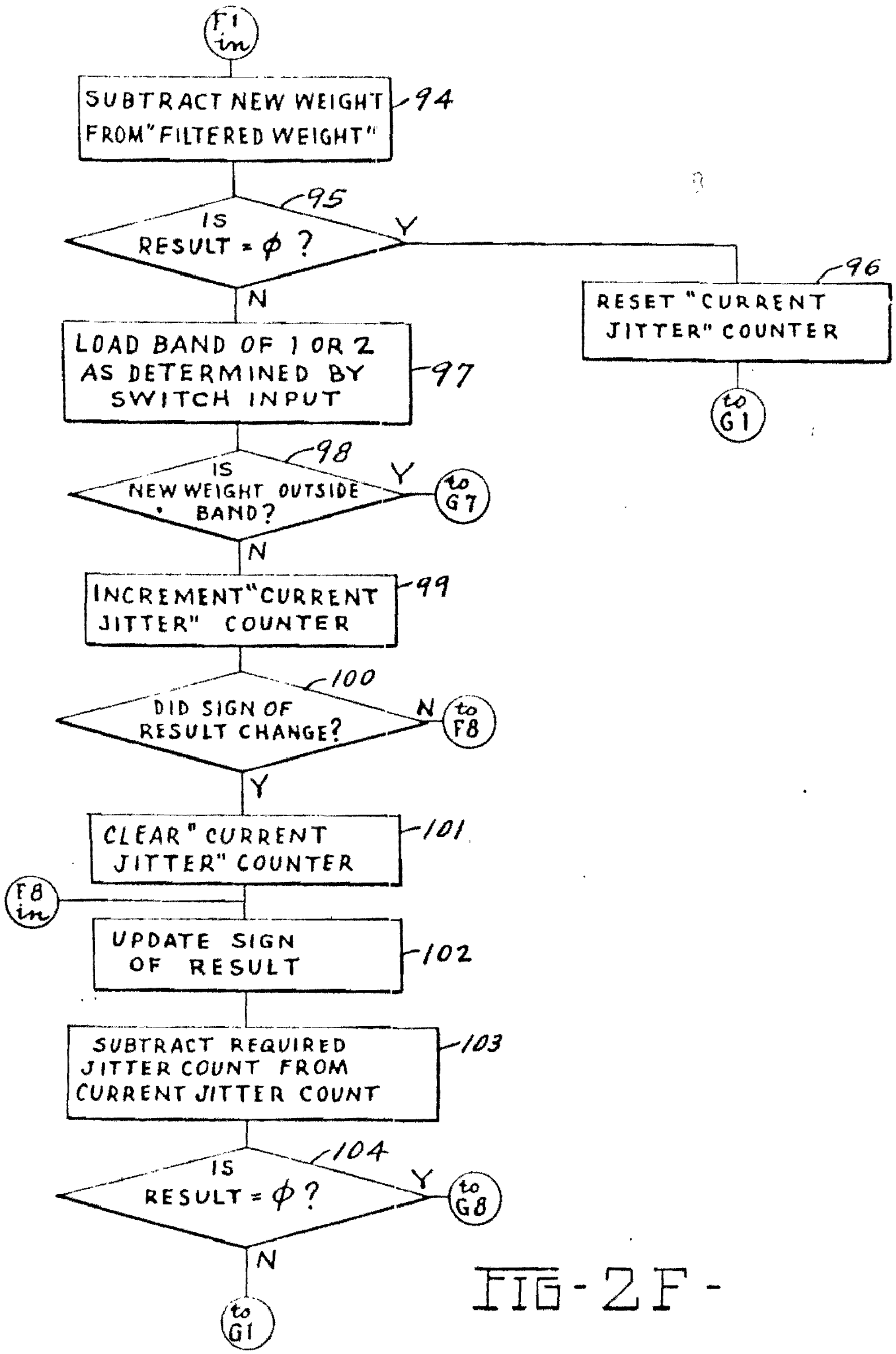

F1 in
SUBTRACT NEW WEIGHT FROM "FILTERED WEIGHT"
94
IS RESULT = φ ?
95
Y
N
RESET "CURRENT JITTER" COUNTER
96
to G1
LOAD BAND OF 1 OR 2 AS DETERMINED BY SWITCH INPUT
97
IS NEW WEIGHT OUTSIDE BAND?
98
Y
to G7
N
INCREMENT "CURRENT JITTER" COUNTER
99
DID SIGN OF RESULT CHANGE?
100
N
to F8
Y
CLEAR "CURRENT JITTER" COUNTER
101
F8 in
UPDATE SIGN OF RESULT
102
SUBTRACT REQUIRED JITTER COUNT FROM CURRENT JITTER COUNT
103
IS RESULT = φ ?
104
Y
to G8
N
to G1

FIG-2F-

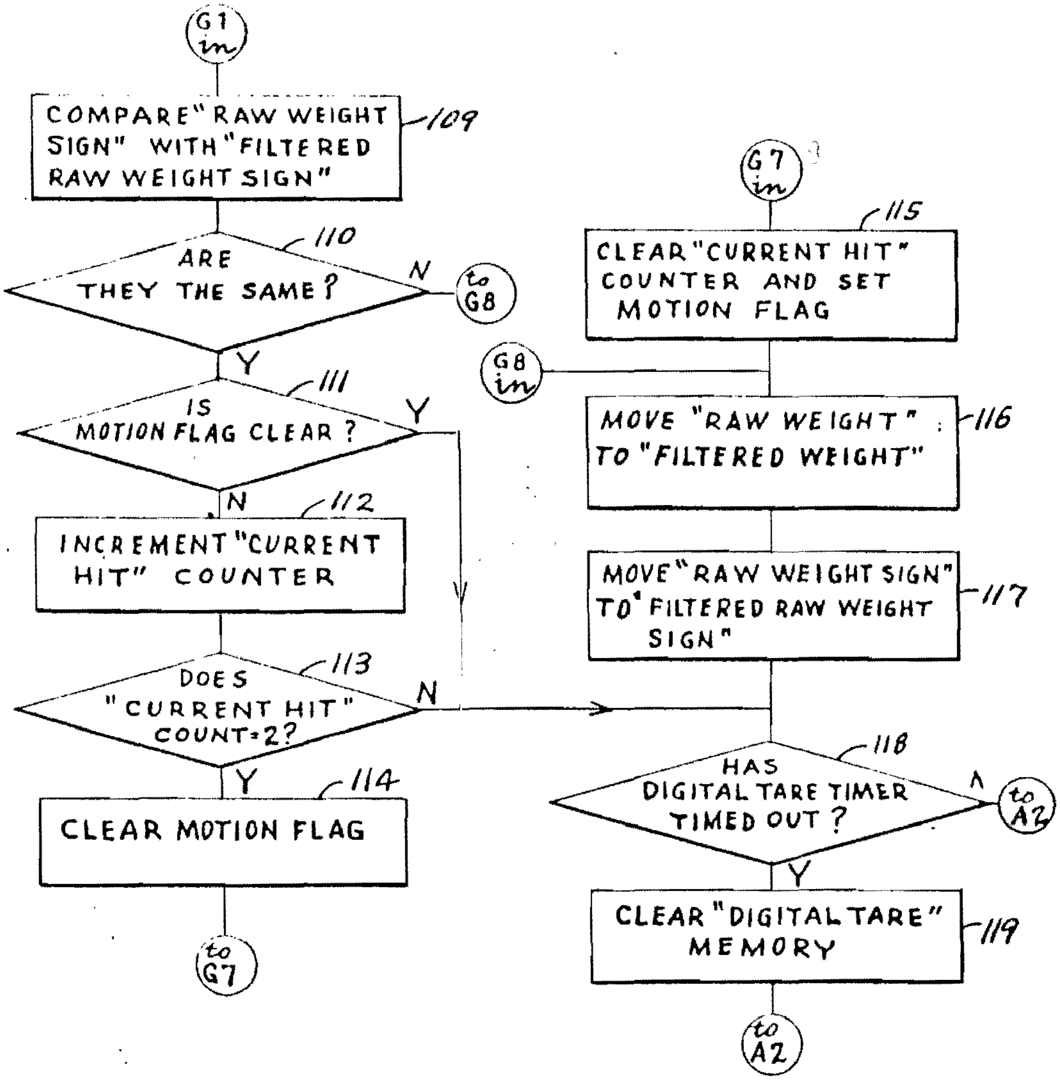

G1 in
COMPARE "RAW WEIGHT SIGN" WITH "FILTERED RAW WEIGHT SIGN"
109
ARE THEY THE SAME?
110
N
to G8
Y
IS MOTION FLAG CLEAR ?
111
Y
N
INCREMENT "CURRENT HIT" COUNTER
112
DOES "CURRENT HIT" COUNT=2?
113
N
Y
CLEAR MOTION FLAG
114
to G7
G7 in
CLEAR "CURRENT HIT" COUNTER AND SET MOTION FLAG
115
G8 in
MOVE "RAW WEIGHT" TO "FILTERED WEIGHT"
116
MOVE "RAW WEIGHT SIGN" TO "FILTERED RAW WEIGHT SIGN"
117
HAS DIGITAL TARE TIMER TIMED OUT ?
118
N
to A2
Y
CLEAR "DIGITAL TARE" MEMORY
119
to A2

FIG-2G-

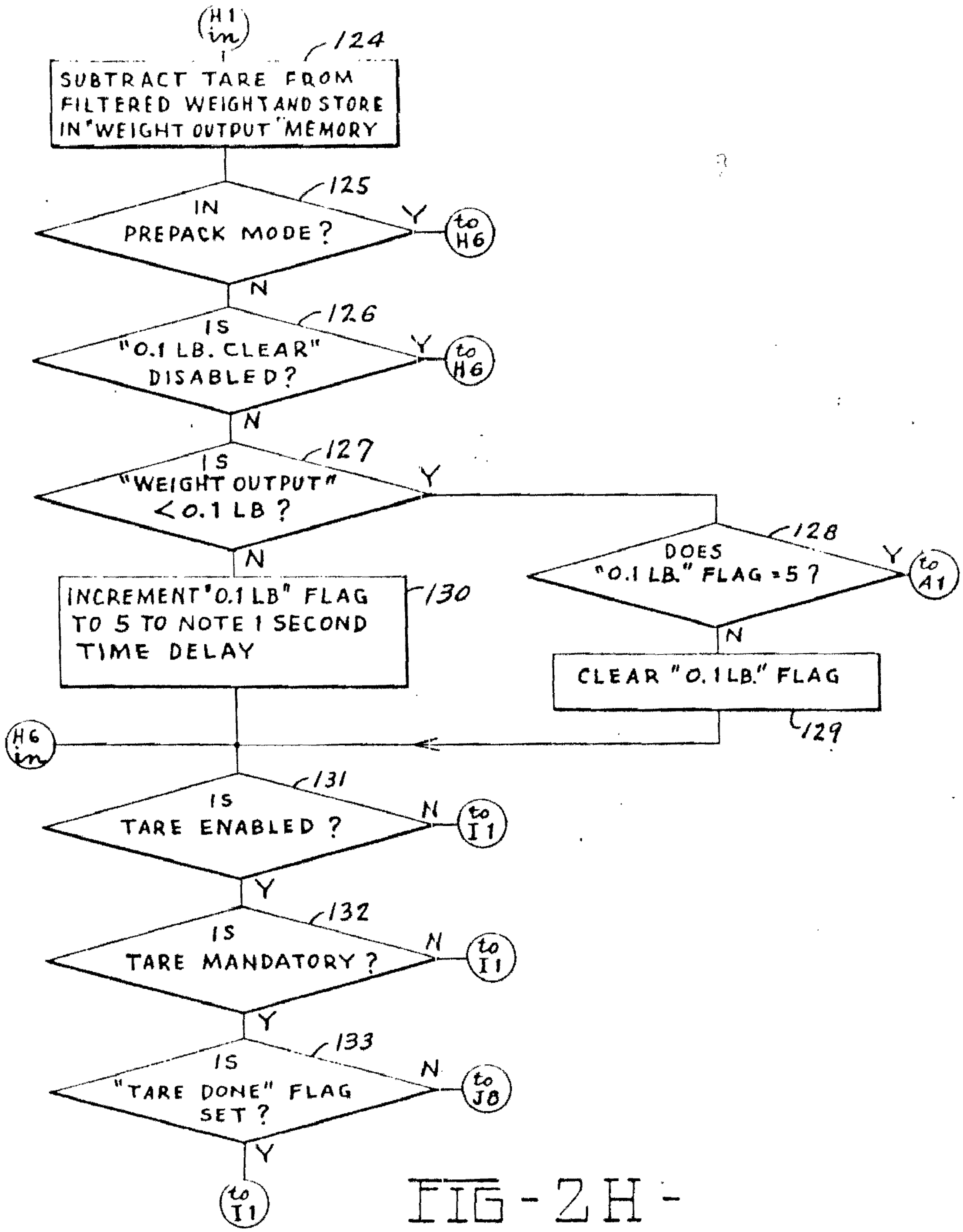

H1 in
124
SUBTRACT TARE FROM FILTERED WEIGHT AND STORE IN "WEIGHT OUTPUT" MEMORY
125
IN PREPACK MODE?
Y
to H6
N
126
IS "0.1 LB. CLEAR" DISABLED?
Y
to H6
N
127
IS "WEIGHT OUTPUT" <0.1 LB?
Y
N
128
DOES "0.1 LB." FLAG = 5?
Y
to A1
N
CLEAR "0.1 LB." FLAG
129
INCREMENT "0.1 LB" FLAG TO 5 TO NOTE 1 SECOND TIME DELAY
130
H6 in
131
IS TARE ENABLED?
N
to I1
Y
132
IS TARE MANDATORY?
N
to I1
Y
133
IS "TARE DONE" FLAG SET?
N
to J8
Y
to I1

FIG-2H-

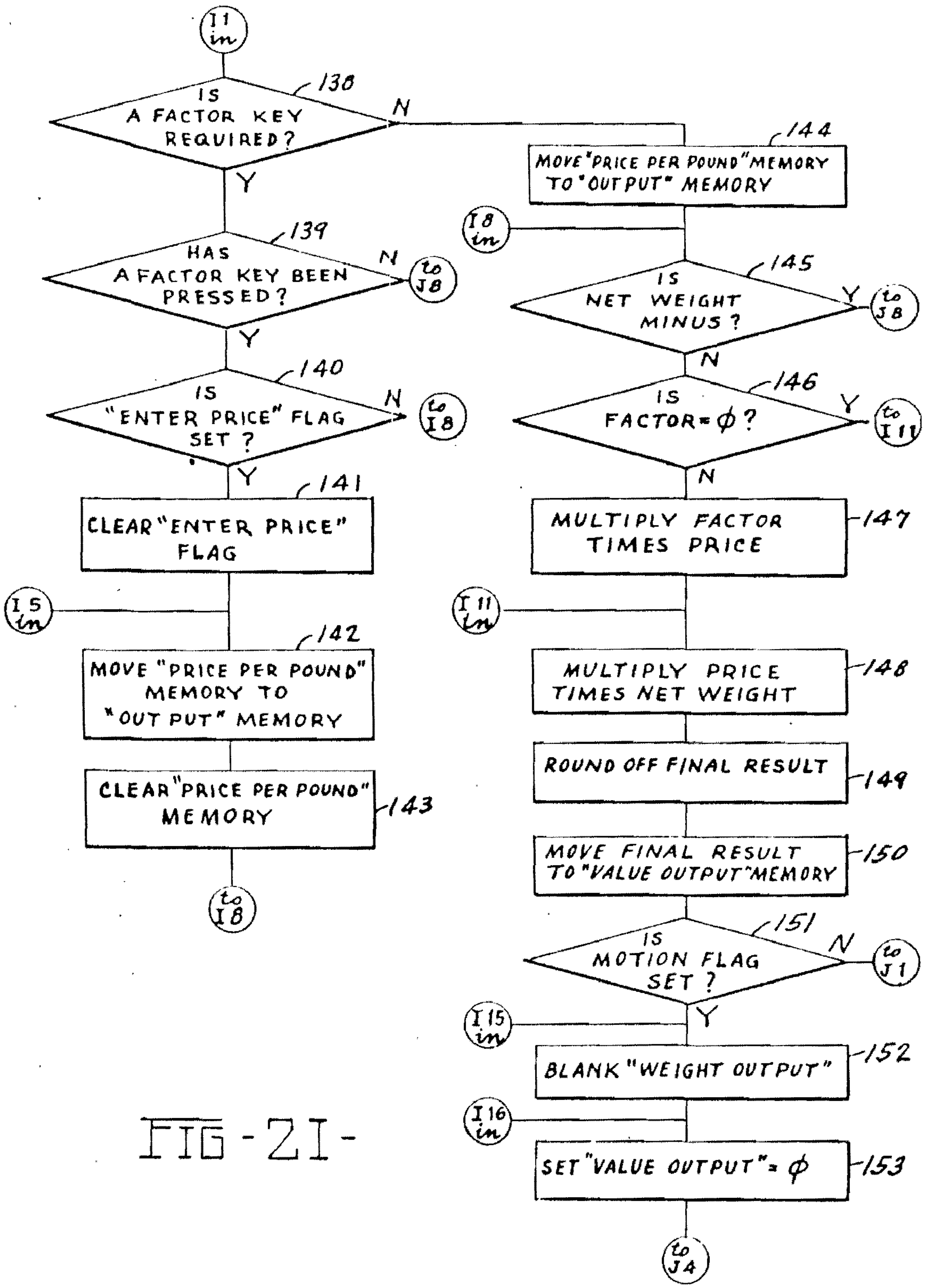

I1 in
IS A FACTOR KEY REQUIRED?
138
N
Y
MOVE "PRICE PER POUND" MEMORY TO "OUT PUT" MEMORY
144
I8 in
139
HAS A FACTOR KEY BEEN PRESSED?
N
to J8
Y
IS NET WEIGHT MINUS?
145
Y
to J8
N
140
IS "ENTER PRICE" FLAG SET ?
N
to I8
IS FACTOR = φ ?
146
Y
to I11
Y
N
141
CLEAR "ENTER PRICE" FLAG
MULTIPLY FACTOR TIMES PRICE
147
I5 in
I11 in
142
MOVE "PRICE PER POUND" MEMORY TO "OUT PUT" MEMORY
MULTIPLY PRICE TIMES NET WEIGHT
148
ROUND OFF FINAL RESULT
149
CLEAR "PRICE PER POUND" MEMORY
143
MOVE FINAL RESULT TO "VALUE OUTPUT" MEMORY
150
to I8
IS MOTION FLAG SET ?
151
N
to J1
I15 in
Y
BLANK "WEIGHT OUTPUT"
152
I16 in
SET "VALUE OUTPUT" = φ
153
to J4

FIG-21-

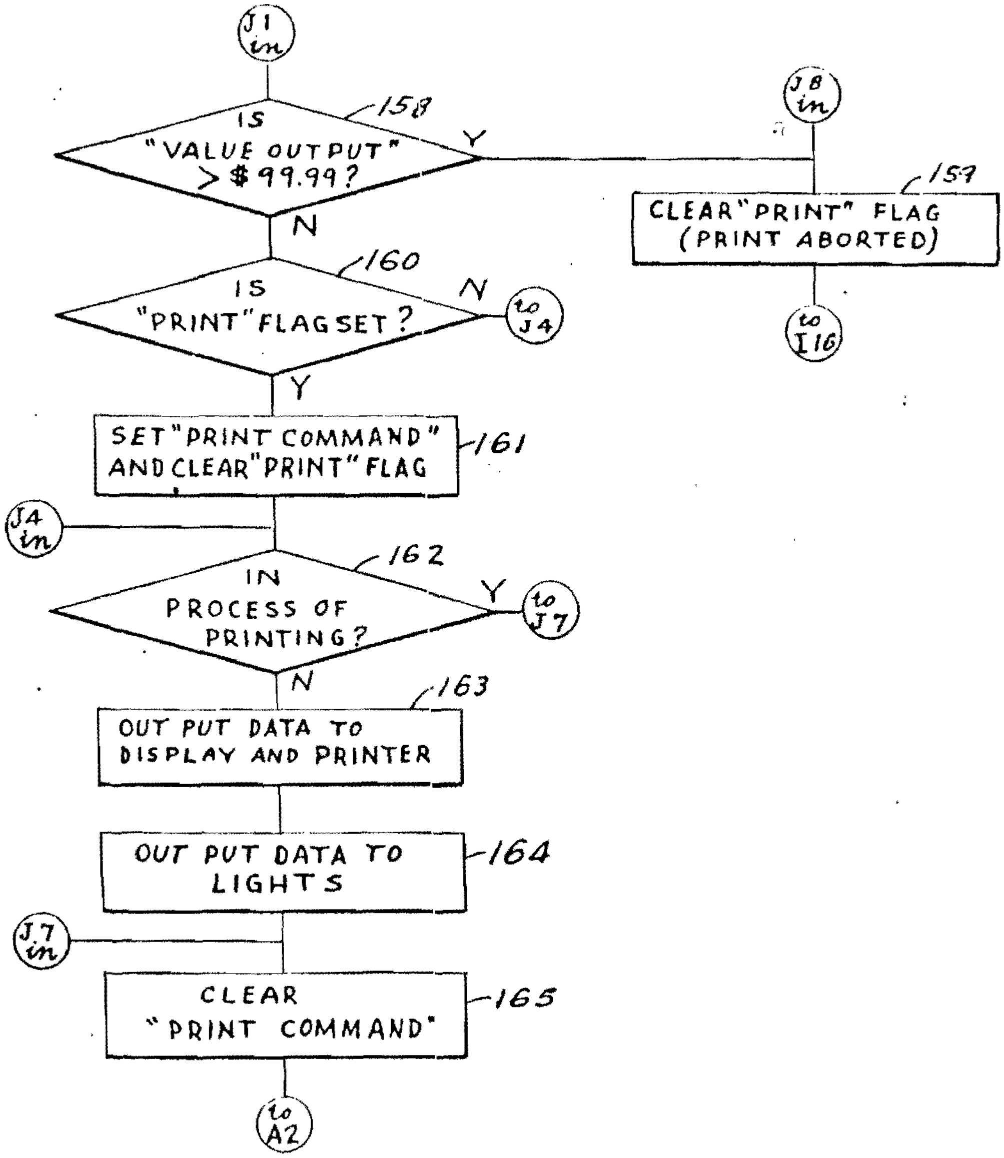

J1 in
IS "VALUE OUTPUT" > $99.99?
158
Y
N
J8 in
CLEAR "PRINT" FLAG (PRINT ABORTED)
159
to I16
IS "PRINT" FLAG SET?
160
N
to J4
Y
SET "PRINT COMMAND" AND CLEAR "PRINT" FLAG
161
J4 in
IN PROCESS OF PRINTING?
162
Y
to J7
N
OUT PUT DATA TO DISPLAY AND PRINTER
163
OUT PUT DATA TO LIGHTS
164
J7 in
CLEAR "PRINT COMMAND"
165
to A2

FIG-2J-

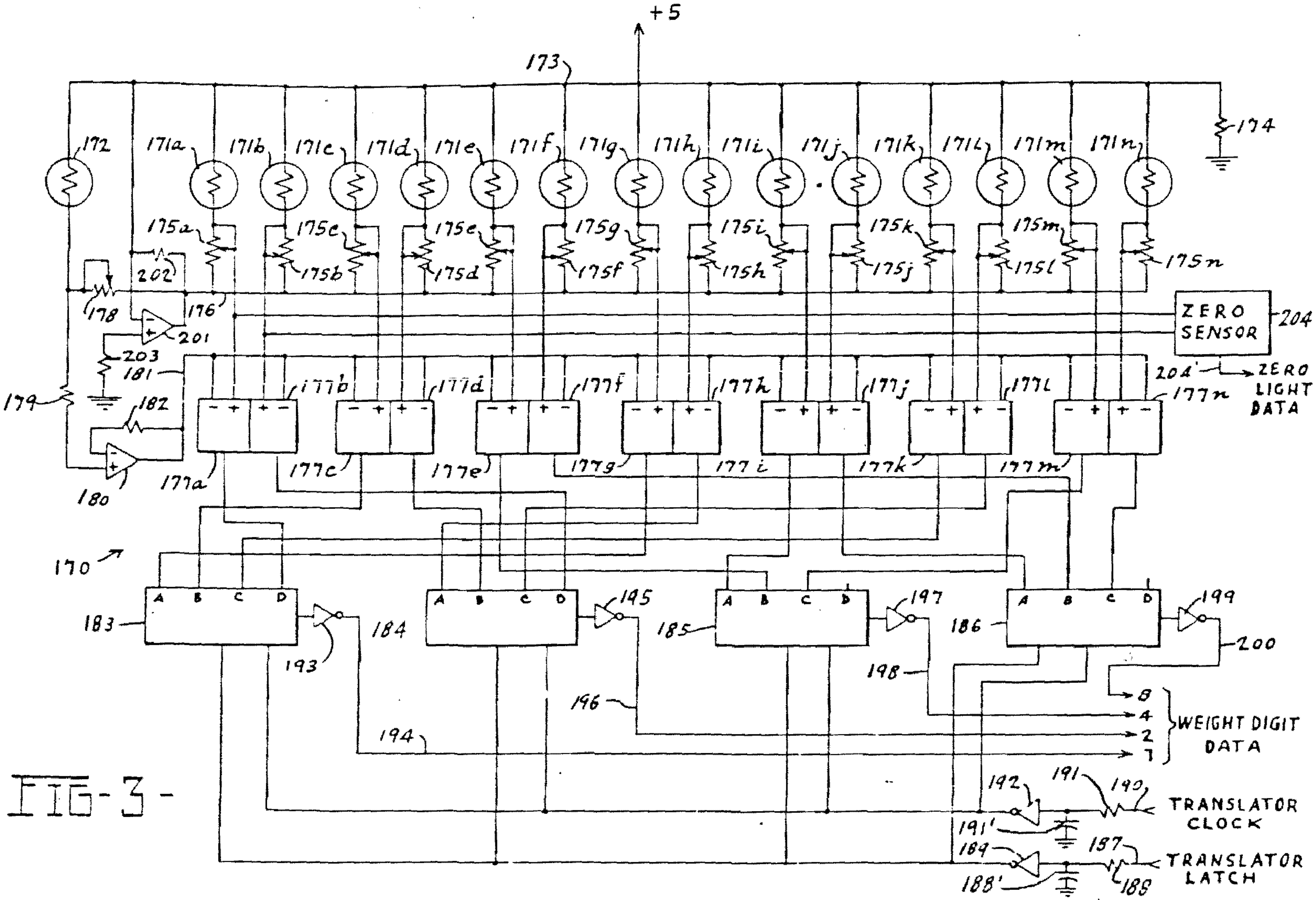

+5
173
174
172
171a
171b
171c
171d
171e
171f
171g
171h
171i
171j
171k
171l
171m
171n
175a
175b
175c
175d
175e
175f
175g
175h
175i
175j
175k
175l
175m
175n
202
178
176
201
203
181
179
182
180
ZERO SENSOR
204
204'
ZERO LIGHT DATA
177a
177b
177c
177d
177e
177f
177g
177h
177i
177j
177k
177l
177m
177n
170
183
184
185
186
193
195
197
199
200
194
196
198
8
4
2
1
WEIGHT DIGIT DATA
192
191
191'
190
TRANSLATOR CLOCK
189
188'
187
188
TRANSLATOR LATCH

FIG-3-

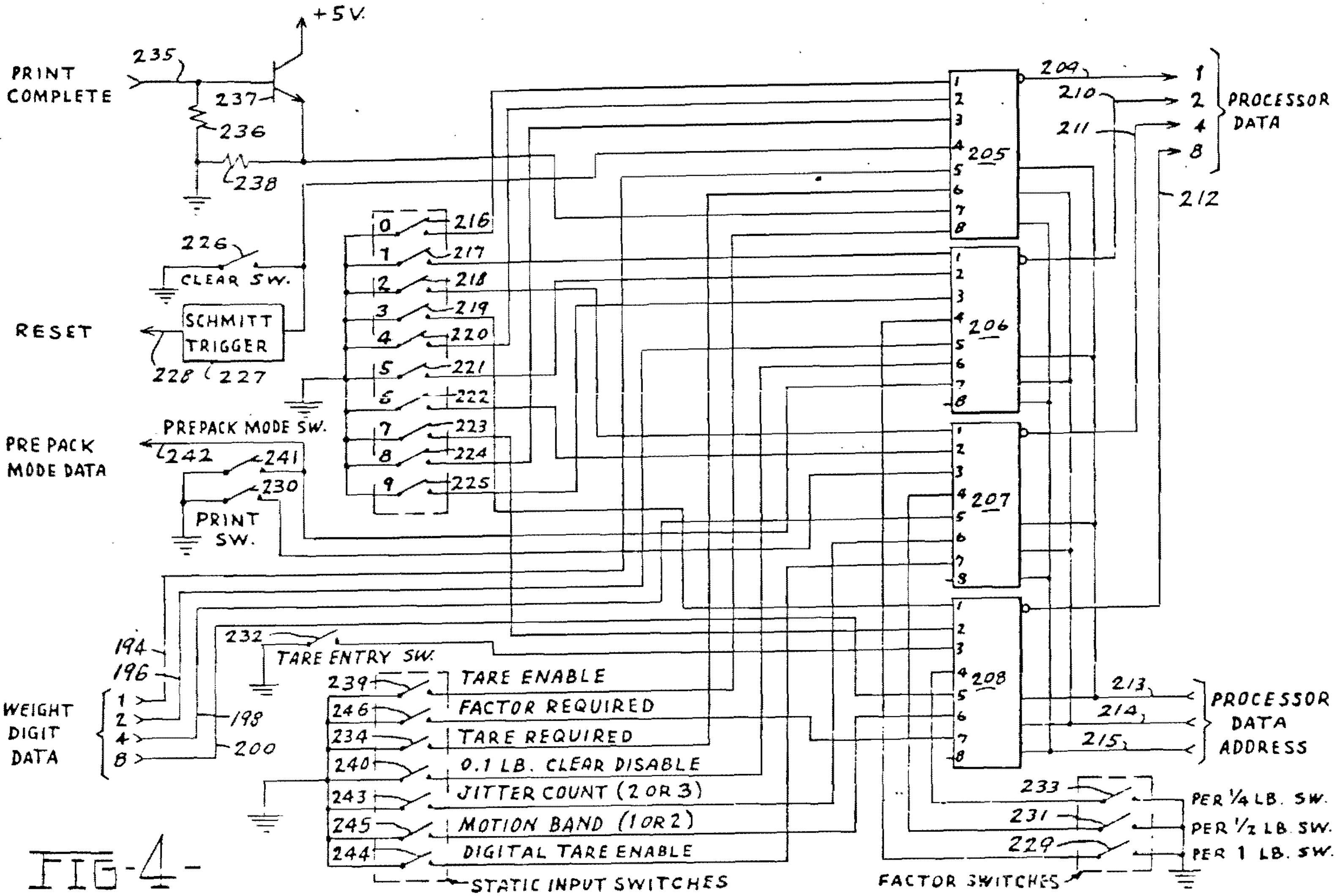

+5V.
PRINT COMPLETE
235
237
236
238
226
CLEAR SW.
RESET
SCHMITT TRIGGER
228
227
PREPACK MODE SW.
PRE PACK MODE DATA
242
241
230
PRINT SW.
0 1 2 3 4 5 6 7 8 9
216 217 218 219 220 221 222 223 224 225
205
206
207
208
209
210
211
212
PROCESSOR DATA
1 2 4 8
194
196
WEIGHT DIGIT DATA
198
200
232
TARE ENTRY SW.
239 TARE ENABLE
246 FACTOR REQUIRED
234 TARE REQUIRED
240 0.1 LB. CLEAR DISABLE
243 JITTER COUNT (2 OR 3)
245 MOTION BAND (1 OR 2)
244 DIGITAL TARE ENABLE
STATIC INPUT SWITCHES
213
214
215
PROCESSOR DATA ADDRESS
233 PER 1/4 LB. SW.
231 PER 1/2 LB. SW.
229 PER 1 LB. SW.
FACTOR SWITCHES

FIG-4-

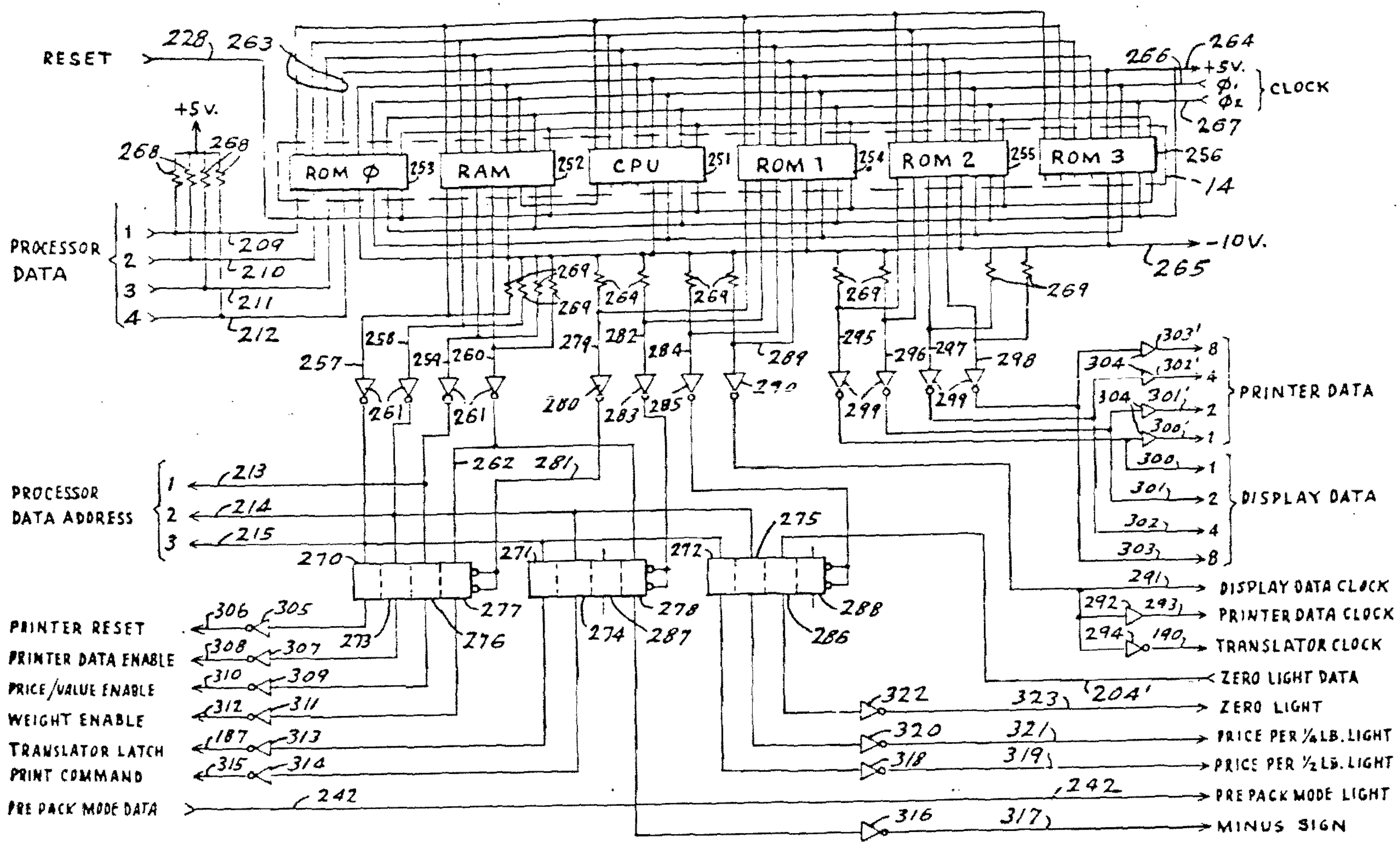

RESET
+5V.
ROM Φ
RAM
CPU
ROM 1
ROM 2
ROM 3
+5V.
Φ1
Φ2
CLOCK
-10V.
PROCESSOR DATA
PROCESSOR DATA ADDRESS
PRINTER DATA
DISPLAY DATA
DISPLAY DATA CLOCK
PRINTER DATA CLOCK
TRANSLATOR CLOCK
ZERO LIGHT DATA
ZERO LIGHT
PRICE PER ¼ LB. LIGHT
PRICE PER ½ LB. LIGHT
PRE PACK MODE LIGHT
MINUS SIGN
PRINTER RESET
PRINTER DATA ENABLE
PRICE/VALUE ENABLE
WEIGHT ENABLE
TRANSLATOR LATCH
PRINT COMMAND
PRE PACK MODE DATA

FIG-5-

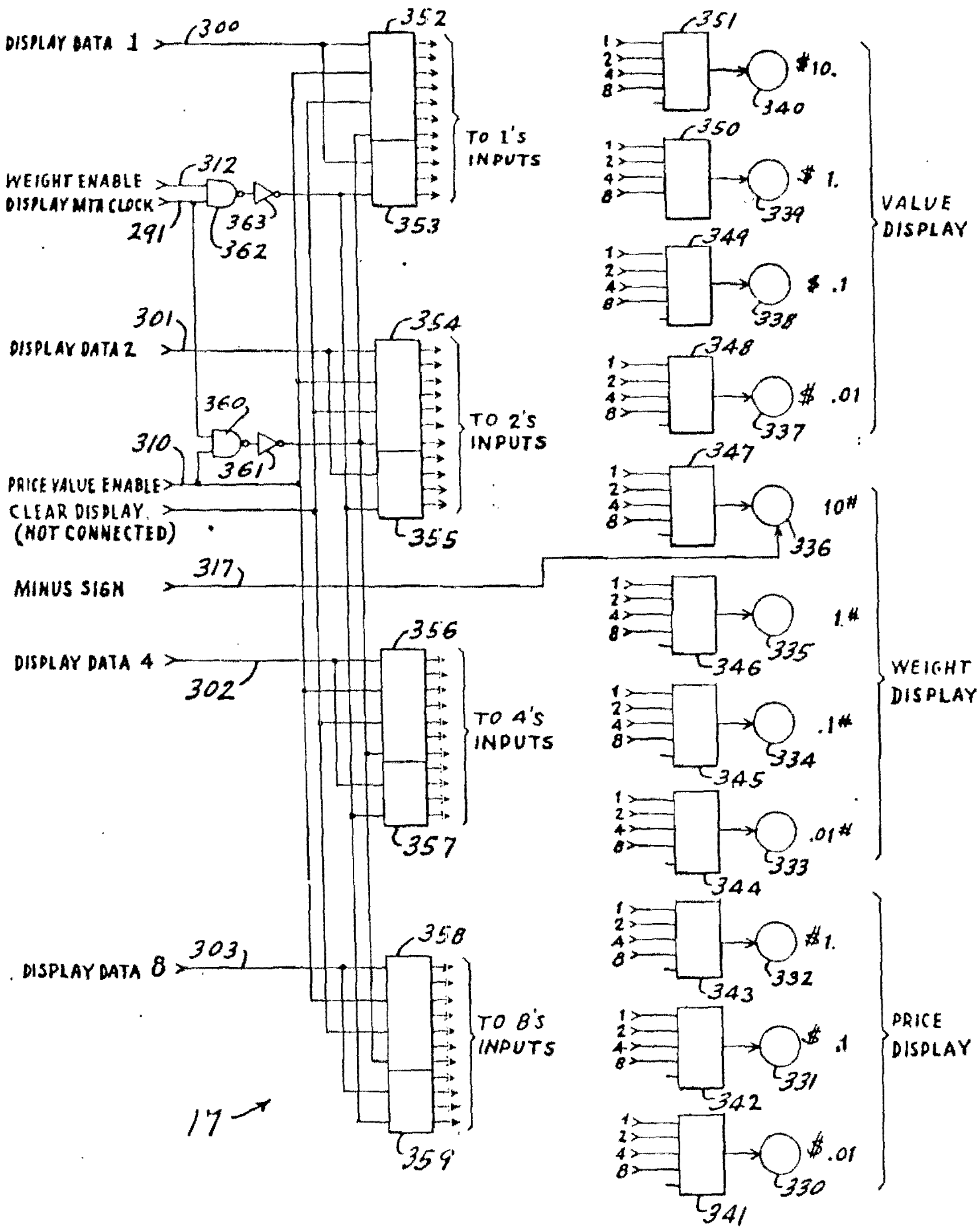

DISPLAY DATA 1
300
352
353
TO 1's INPUTS
WEIGHT ENABLE
DISPLAY MTR CLOCK
291
312
363
362
301
DISPLAY DATA 2
354
355
TO 2's INPUTS
360
310
361
PRICE VALUE ENABLE
CLEAR DISPLAY (NOT CONNECTED)
MINUS SIGN
317
DISPLAY DATA 4
302
356
357
TO 4's INPUTS
DISPLAY DATA 8
303
358
359
TO 8's INPUTS
17
351
340
$10.
350
339
$ 1.
349
338
$ .1
348
337
$ .01
VALUE DISPLAY
347
336
10#
346
335
1#
345
334
.1#
344
333
.01#
WEIGHT DISPLAY
343
332
$1.
342
331
$ .1
341
330
$.01
PRICE DISPLAY

FIG-6-

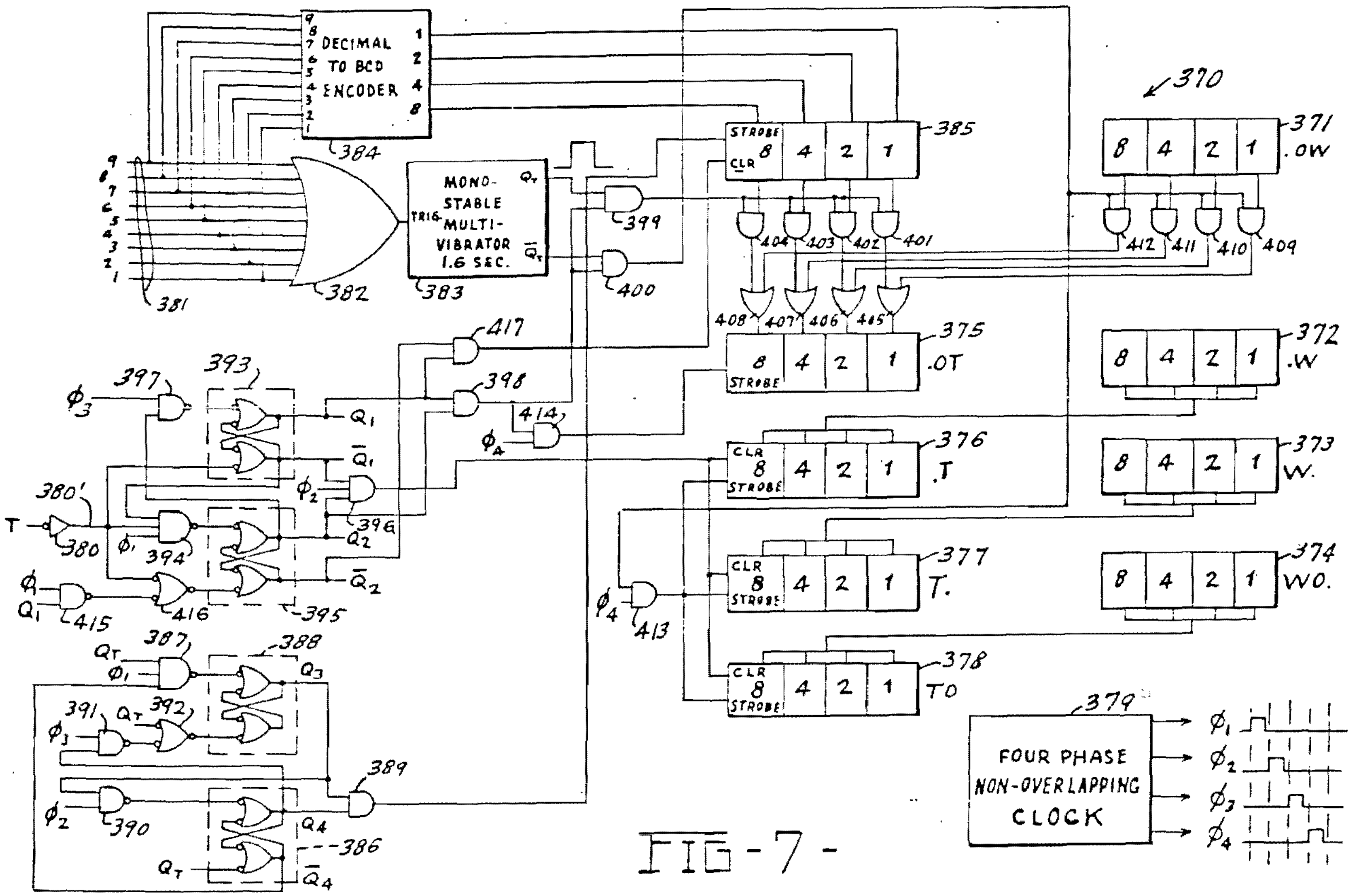

DECIMAL TO BCD ENCODER
384
MONO-STABLE MULTI-VIBRATOR 1.6 SEC.
TRIG
383
382
381
STROBE
CLR
8 4 2 1
385
370
371
.OW
372
.W
373
W.
374
WO.
375
.OT
376
.T
377
T.
378
TO
FOUR PHASE NON-OVERLAPPING CLOCK
379
ϕ_1
ϕ_2
ϕ_3
ϕ_4
380
380'
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
386
387
388
389
390
391
392
Q_1
$\bar{Q}_1$
Q_2
$\bar{Q}_2$
Q_3
Q_4
$\bar{Q}_4$
Q_T
$\bar{Q}_T$
T

FIG-7-

VALUE COMPUTING SCALE

BACKGROUND OF THE INVENTION

This invention relates to computing scales and more particularly to an improved computing scale which weighs an article and computes desired data from the article weight such as an article value based upon the article weight and a predetermined price per unit weight.

Computing scales are used in many industries for weighing articles and computing desired data from the article weight. Computing scales are, for example, commonly used in the retail food sales industry for weighing meats, produce and similar articles sold by weight and for computing from the article weight the value of such article based upon a predetermined price per unit weight. The article weight and the computed value are then displayed to the store clerk and to customers and, in some cases, are also automatically printed on an article label.

Computing scales are also used for obtaining data other than the value of articles. Such scales, for example, are sometimes used for obtaining a count of the number of pieces in a container. The scales weigh the number of pieces in the container and divide the measured weight by an average weight per piece for obtaining a piece count. Or, computing scales may be used for obtaining a net weight of a material having a known percentage, by weight, of impurities. For example, if it is known that a particular material has a moisture content of 2% by weight, it may be desired to multiply the measured gross weight from a scale by 98% so that the net or dry weight of the material is indicated.

Computing scales have become very sophisticated and highly accurate with the development of digital computing techniques. Advance computing scales convert a measured gross article weight into a digital format, subsequently convert the digitized gross weight into a digital net weight, and multiply the net weight by a price per unit weight or some other factor in a digital computer. The result appearing at the computer output may then be displayed on a digital readout, such as on Nixie tube readouts or on seven-segment readout devices. In some instances, a record is also printed on the computer output. The record may, for example, consist of a label for application to the article being weighed.

The use of digital techniques and the greatly increased accuracy of modern digital computing scales has accentuated some problems which were generally of little concern in the relatively slow and less accurate prior art analog computing scales. One such problem area is jitter in the measured weight. As used herein, weight "jitter" refers to very small fluctuations or oscillations in the measured weight generally caused by small vibrations of either the article being weighed or the scale. Digital computing scales used for retail sales typically indicate weight to 1/100th of a pound. At this accuracy, a relatively small vibration may cause the indicated digital weight to jitter between two or more values. This problem is accentuated when an article has a weight between two values. If, for example, an article weighs 9.135 pounds and the scale indicates only to 1/100th of a pound, the displayed weight will tend to jitter or alternate between 9.13 pounds and 9.14 pounds. This in turn may cause data computed from the article weight to jitter between two values.

Computing scales are generally provided with means for supplying a tare weight to the computer for use in determining net weights. In many scales, a separate set of buttons or switches are used solely for tare weight entries. More sophisticated computing scales may measure the tare weight on the scale and automatically enter the measured tare weight when an "enter tare" switch is closed. These scales are often provided with a switch for selecting either an automatic mode or a manual mode for entering tare weights. However, the mode selecting switches and the manual tare entry keys are not always convenient and there is a possibility of entering an erroneous tare weight. Furthermore, when the scale is designed to compute values, a separate set of keys or switches has generally been required for entering price per unit weight data. This results in an unnecessary duplication of switches or keys for entering data into the computer.

SUMMARY OF THE INVENTION

According to the present invention, apparatus for weighing and digitally computing a value for articles is provided with improved circuitry for filtering weight signals to eliminate the effects of jitter and with improved circuitry for entering digital tare weight data in either manual or automatic operating modes. A digital scale is connected through an interface to provide gross weight data to an integrated circuit microcomputer. A digital keyboard is also connected to the interface for supplying both price per unit weight data and tare weight data to the microcomputer The keyboard also includes a "tare entry" key. The apparatus is designed such that if the tare entry key is pushed within a predetermined time interval after a digit key has been pushed, the microcomputer recognizes the digit only as a tare weight digit. If the tare entry key is not pushed within the time interval, the digit is recognized only as a price per unit weight digit. Thus, the entered digit is no longer recognized as a tare digit but remains stored as a price per unit weight digit. If the tare entry key is pushed when a digit key had not been pushed within the preceding predetermined time interval, the current weight on the scale is entered into the microcomputer as the tare weight. The microcomputer computes a net weight for an article placed on the scale from the measured gross weight and the tare weight and subsequently computes a value from the net weight and the price per unit weight. The net weight, the price per unit weight and the value are then supplied to a digital display and, optionally, to a label printer.

The keyboard also may be used for entering fractional price data. For example, the entered price may be "per ½ pound" or "per ¼ pound." When fractional prices are entered, the microcomputer normalizes the price data to a price per unit weight prior to computing a value. The price data is normalized by multiplying the entered fractional price by a factor. If an entered price is, for example, per ¼ pound, it is multiplied by a factor of four to obtain a price per pound.

The digital weight data from the scale is filtered to eliminate jitter or any ambiguity between adjacent digital increments. The measured gross weight is periodically compared with a filtered weight which is used by the microcomputer for computing the net weight and the article value If the compared weights differ by more than a predetermined amount, a motion signal is generated and the filtered weight is revised to the value of the measured gross weight. If they differ by less than the predetermined amount, a counter is incremented. The counter is cleared whenever the two weights are equal or the filtered weight is revised. The filtered weight is also revised when the counter reaches a predetermined count. Thus, if jitter causes the measured gross weight to alternate between two adjacent values, e.g., 9.13 pounds and 9.14 pounds, and the filtered weight is one of these values, e.g., 9.13 pounds, then the counter will never be incremented to the predetermined count. The displayed weight and the weight used for computing a value will then remain constant. The motion signal, which may be used to blank the weight display and/or to inhibit a printer, is extinguished when the filtered weight and the measured gross weight are equal for a predetermined number of successive comparisons.

Accordingly, it is a preferred object of the invention to provide improved apparatus for weighing and computing a value for articles.

Another object of the invention is to provide improved circuitry for filtering weight data from a digital scale to prevent jitter and ambiguities between adjacent weight increments.

Still another object of the invention is to provide improved circuitry for manually or automatically entering tare weight data into a scale system.

Other objects and advantages of the invention will become apparent from the following detailed description, with reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of apparatus for weighing and computing a value for articles embodying the principles of the present invention;

FIG. 2, which consists of FIGS. 2A through 2J, is a flow diagram showing the operation of apparatus for weighing and computing a value for articles according to the present invention;

FIG. 3 is a detailed schematic logic circuit diagram of one embodiment of the translator portion of a scale for use in apparatus for weighing and computing a value for articles according to the present invention;

FIG. 4 is a schematic logic circuit diagram of a keyboard and data input multiplexer for use in apparatus for weighing and computing a value for articles according to the present invention;

FIG. 5 is a detailed schematic logic circuit diagram of a data processor, digital memories and interface for use in apparatus for weighing and computing a value for articles in accordance with the present invention;

FIG. 6 is a detailed logic circuit diagram of a digital display for use in apparatus for weighing and computing a value for articles according to the present invention;

FIG. 7 is a logic circuit diagram of a modified embodiment of apparatus for manually or automatically entering tare weight data into a scale system in accordance with the present invention; and

FIG. 8 is a logic circuit diagram of apparatus for filtering digital weight data according to the present invention to prevent ambiguities between adjacent weight increments.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to the drawings and particularly to FIG. 1, a block diagram is shown of apparatus 10 for weighing and computing a value for articles embodying the principles of the present invention. The apparatus 10 includes a scale 11 for supplying a weight signal in a digital format to interface and input data multiplexer circuitry 12. Data is also applied from a keyboard 13 to the interface and multiplexer 12. From the interface and multiplexer 12, the scale and keyboard data passes to a data processor 14 which includes an arithmetic logic unit 15 and one or more digital memories 16. The scale 11 and the keyboard 13 supply gross weight data, tare weight data and price data to the data processor 14. The arithmetic logic unit 15 subtracts the tare weight from the measured gross weight for an article to obtain a net weight. If necessary, the price data is normalized and the net weight is subsequently multiplied by the price per unit weight for obtaining a value for the weighed article. The net weight data, the price data and the computed value are then passed through the interface 12 to a digital display 17 and also may be supplied to an optional printer 18 for use in printing a label for the weighed article.

The apparatus 10 is designed to provide a maximum degree of accuracy in the measured article weight and the computed value. The possibility of an erroneous data entry from the keyboard 13 caused, for example, by contact bounce, is minimized by repeatedly scanning the keyboard 13 at a relatively fast rate. Data is stored in the memory 16 only after the data is received from the keyboard 13 for a predetermined number of successive scans, such as three successive scans at a rate of one scan each 15 millisecond.

Data from the scale 11 is also filtered to minimize the effects of jitter or ambiguities between two adjacent weight increments caused by vibration of the scale or an article on the scale. The arithmetic logic unit 15 uses a filtered weight value stored in a portion of the memory 16 for computing the net weight and the article value. The digital output applied from the scale 11 to the interface and multiplexer 12 is periodically scanned and compared with the stored filtered weight. If the two weights differ by more than a predetermined amount, a motion signal is generated and the filtered weight is revised to the value of the measured gross weight from the scale 11. If they differ by less than the predetermined amount, a counter within the arithmetic logic unit 15 is incremented. The counter is cleared whenever the two weights are equal or the filtered weight is revised. The filtered weight is also revised to the measured gross weight when the counter reaches a predetermined count, such as two or three. The motion signal, which may be used to blank the weight shown on the digital display 17, to inhibit a value computation, and to prevent the printing of a label by the printer 18, is extinguished when the filtered weight and the measured gross weight are equal for a predetermined number of successive comparisons. Thus, if the output from the scale 11 alternates on successive cycles between two numbers such as 9.13 pounds and 9.14 pounds and the filtered weight stored in the memory 16 is 9.13 pounds, the counter will be alternately incremented and cleared as the weight jitters between the two values. Since the counter is not incremented up to the predetermined count, the filtered weight remains constant at 9.13 pounds and ambiguities in the weight supplied to the arithmetic logic unit 15, to the digital display 17 and to the printer 18 are eliminated.

The tare weight may be supplied to the data processor 14 either in an automatic mode from the scale 11 or in a manual mode from the keyboard 13. The keyboard 13 includes a tare entry key which must be actuated each time a tare weight is entered into the data processor 14. The keyboard 13 also includes a set of ten digit keys for supplying data through the interface and multiplexer 12 to the data processor 14. When a digit key on the keyboard 13 is pushed, the digit is stored in both a price portion of the memory 16 and in a temporary tare weight portion of the memory 16. At the same time, a timer is started for measuring a predetermined time interval which is generally on the order of one to two seconds. If the tare entry key is then pushed before the measured time interval has elapsed, the price memory is cleared and the number stored in the temporary tare memory is shifted into a second tare weight memory for use by the arithmetic logic unit 15 in computing a net weight. The display 17 will then show the manually entered tare weight as a negative value until an article is placed on the scale 11. If the tare entry key is not pushed, the temporary tare memory will be cleared when the timer shuts off after measuring the predetermined time interval and the entered number will be used only as a price digit. If, on the other hand, the tare entry key is pushed and the timer is not currently on, the digital output from the scale 11 will be stored in the tare weight memory for use in computing a net weight. Since the gross weight and the entered tare weight are now equal, the net weight shown on the display 17 will be zero. A container or package placed on the scale 11 for obtaining the tare weight may then be filled with one or more articles for which a value is to be computed.

The keyboard 13 may also include additional keys which are used for fractional pricing, for selecting a "prepack" mode of operation, for clearing all data entered into the memories 16 and for activating the printer 18. In the fractional pricing mode of operation, entered price data will be considered by the data processor 14 as a price per fractional unit weight such as $1.19 per ½ pound or $1.19 per ¼ pound. If the price is per ½ pound, the arithmetic logic unit 15 multiplies the entered $1.19 by two and uses the resulting $2.38 per pound for computing a value. Similarly, if the price is per ¼ pound, the arithmetic logic unit 15 multiplies by a factor of four. During normal operation of the apparatus 10 in, for example, a delicatessen, it may be desirable to clear the digital memory 16 each time an article is removed from the scale 11. Thus, new tare weight data and price data must be entered for each article for which a value is to be computed. During the normal mode of operation, the price and tare memories are cleared each time the weight output from the scale 11 goes above a predetermined weight for a predetermined time and then falls below the predetermined weight. However, at times it may be desirable to use the apparatus 10 for preparing labels for a series of identical articles, such as packages of swiss cheese, all of which have the same price per unit weight and the same tare weight. A prepack key is provided on the keyboard 13 for selecting the operating mode of the apparatus 10. When the apparatus 10 is in the prepack mode of operation, the memories 16 will not be cleared when an article is removed from the scale 11. Thus, the entered tare weight data and price data are maintained from article to article. In addition, government regulations commonly prohibit the use of fractional pricing for articles which are prepackaged and labeled. Therefore, when the apparatus 10 is in the prepack mode of operation, operation of the fractional pricing keys on the keyboard 13 is inhibited.

Prior to considering the detailed circuitry for the apparatus 10 for successively weighing and computing the value of a plurality of articles, attention is directed to FIGS. 2A through 2J which show a flow diagram for a preferred operating sequence of the apparatus 10. The flow diagram consists of a series of blocks in the shape of diamonds or rhombuses and rectangles. Each diamond corresponds to a question having either a yes or no answer which may be asked by conventional logic circuitry in the microcomputer 14. Each rectangular block corresponds to the performance of a specific function such as storing a value in a memory or causing a label to be printed. In reading the flow diagram, entry is made to the top or left of a block and the logic flows downwardly and to the right. The numbers placed in the circles to the top and left of the blocks represent input locations. For example, the "A2 in" in a circle on the left of the flow diagram in FIG. 2A represents an input to the second block from the top in sheet A of FIG. 2. The numbers in the circles to the right of or below the blocks in the flow diagram represent an output connected to a different location in the flow diagram. For example, the circle below the block 33 at the lower right of FIG. 2A is designated "to B1." This indicates that a jump is made from this block to the input to the first block in sheet B of FIG. 2.

Referring now to FIG. 2A, the flow diagram is initially entered through an A1 input to a block 23 at which the apparatus 10 is cleared and initialized in preparation for weighing and computing a value for an article. The block 23 and an A2 input are connected to a block 24 at which the data processor 14 prepares to do six scans of the keyboard 13. The block 24 and an A3 input are connected to a block 25 in which a "key" flag is cleared. As used herein in discussing the flow chart of FIGS. 2A through 2J, a flag indicates a latch, a flip-flop or a bit stored in a memory to indicate the occurrence or non-occurrence of a condition. The key flag, for example, indicates that a key on the keyboard 13 has been depressed. The block 25 and an A4 input are connected to a block 26 in which the keyboard 13 is scanned to read any depressed key. From the block 26, a check is made to see if a key is actually depressed during a scan at a block 27. If not, a jump is made to an A10 input, while if a key is depressed a check is made to see if the key flag is set at a block 28. If the key flag is already set, it indicates that multiple keys on the keyboard 13 are simultaneously depressed and a "key depress" memory is cleared at a block 29 and the logic jumps to an A11 input. If a key was depressed and the key flag was not set, the block 28 is connected to a block 30 at which the key flag is set. After the key flag is set, the key depress memory is incremented at a block 31.

According to the following described embodiment of the apparatus 10, a key must be recognized as being depressed for three successive scans before data is entered into the memory 16. The key depress memory indicates the number of successive times a key has been recognized. From the block 31, a check is made at a block 32 to see if all sixteen keys on the keyboard 13 have been looked at. If not, the logic returns to the A4 input while if they have all been looked at, the block 32 and an A11 input are connected to a block 33 wherein static inputs are read and data from such static inputs is stored in the memory 16. The static inputs consist of a plurality of internal switches within the apparatus 10 which permit selecting various optional operating modes and interlocks. Once these switches are set for a particular installation, they are normally not changed unless the operating requirements for the apparatus 10 change. The static inputs may include, for example, a "tare enable" switch, a "tare required" switch, a "factor required" switch, a switch which determines if the apparatus 10 is to be cleared whenever a package or article is removed from the scale 11 and the weight drops below 0.1 pound, a switch which establishes the jitter count required to change weight data in the memory 16, a switch which determines the bandwidth for the motion detector and a switch which enables or disables the manual entry of tare weights through the keyboard 13. After the static inputs are read at the block 33, the logic jumps to the B1 input.

Turning to FIG. 2B, the B1 input is connected to a block 38 at which the apparatus 10 is set up to examine the ten digit keys on the keyboard 13. The output from the block 38 and the B2 input are connected to a block 39 at which a check is made to see if the digit key depressed count equals three. If not, the logic jumps to a B5 input. If the count does equal three, it indicates that the digit key is actually pressed and the contents of a "price per pound" memory are shifted left one digit and the latest digit from the keyboard 13 is stored in the least significant digit location at a block 40. If a key is not pushed for a count of three, it is assumed that noise is present and that the key was not pushed. In a similar manner, the contents of a "digital tare" memory are then shifted left one digit and the same digit is stored in the least significant digit location at a block 41. At the same time, a digital tare timer is started. The digital tare timer measures a predetermined time interval generally within the range of one to five seconds and, for example, may measure 1.6 seconds. If a manual tare entry is to be made through the keyboard 13, the predetermined time interval must be sufficiently long to allow an operator to press a tare entry key after a digit key is pushed. It has been found that 1.6 seconds is generally adequate.

The output of the block 41 and the B5 input are connected to a block 42 at which a check is made to see if all ten digit keys have been looked at. If not, the logic returns to the B2 input while if they have, the logic moves to a block 43 in which a check is made to see if a print key has been pushed for a count of three. If the print key has not been pushed for a count of three, the logic jumps to a B8 input, while if it has, a block 44 sets a print flag. The block 44 and the B8 input are connected to a block 45 at which a check is made to see if the tare entry key has been pushed for a count of three. If the tare entry key has not been pushed for a count of three, the logic jumps to a C9 input while if it has been pushed for a count of three, a tare memory which supplies the tare weight to the arithmetic logic unit 15 in the data processor 14 is cleared at a block 46. From the block 46, a check is made at a block 47 to see if one of the static or internal switches is set to enable the entry of a tare weight. If the switch is not set, then the gross weight from the scale 11 will always be used for computing values and the logic jumps to a C8 input, while if the entry of a tare weight is enabled, the logic jumps to a C1 input.

Referring now to FIG. 2C, the C1 input is applied to a block 51 at which a check is made to see if one of the static or internal switches is set to enable entry of a digital tare weight through the keyboard 13. If so, then a check is made to see if the digital tare memory is nonzero at a block 53. The digital tare memory is the temporary memory which stores digits manually entered through the keyboard 13. If a tare weight has been entered through the keyboard 13, causing the digital tare memory to be non-zero, the contents of the digital tare memory are moved at a block 54 to the tare memory which supplies data to the arithmetic logic unit 15 and the logic then jumps to a C7 input. If either the static switch is not set to enable a manual tare entry or the digital tare memory is zero, the blocks 52 and 53 are connected to a block 55 at which a check is made to see if the gross weight appearing at the output of the scale 11 is negative. If the gross weight is negative or minus, the logic jumps to the C7 input. If the gross weight is not minus, the filtered gross weight is moved to the tare memory at a block 56. Thus, a tare weight is automatically entered from the scale 11 when a tare weight is not entered from the keyboard 13 into the digital tare memory.

After the filtered gross weight is moved to the tare memory, a "0.1 pound" flag which is normally set when the scale output drops below 0.1 pound is cleared at a block 57. The output of the block 57 and the C7 input are applied to a block 58 which sets a "tare done" flag or latch to indicate that a tare weight has been entered into the tare memory. The block 58 and the C8 input are connected to a block 59 at which the price per pound memory and the entire "output digit" memory which supplies data to the digital display 17 and the printer 18 are cleared. The output of the block 59 and the C9 input are connected to a block 60 at which a check is made to see if a "clear" key on the keyboard 13 has been depressed for a count of three. If so, the logic returns to the A1 input and the apparatus 10 is cleared and initialized for a new cycle. If the clear key has not been pressed for a count of three, a check is made at a block 61 to see if a per pound key on the keyboard 13 has been pushed for a count of three. If not, the logic jumps to a D1 input, while if it has been depressed for a count of three, a "factor" memory is set to one and an "enter price" flag is set at a block 62. The contents of the factor memory are multiplied times an entered price in the price per pound memory to obtain the actual price per pound when fractional pricing is used. Thus, when the per pound key is depressed and a one is stored in a factor memory, the result will equal the entered price. As will be shown in FIG. 2D, if the price is per ½ pound or per ¼ pound, a two or a four, respectively, is stored in the factor memory for multiplying times the entered price to obtain the actual price per pound. From the block 62, the logic moves to the D1 input.

The D1 input is connected to a block 67 in FIG. 2D. A check is made at the block 67 to see if the apparatus 10 is in a prepack mode of operation as is determined by the setting of a switch on the keyboard 13. If the apparatus 10 is set to the prepack mode, the logic jumps to a D6 input to prevent entry of a factor of two or four into the factor memory. If the apparatus 10 is not in the prepack mode, a check is made at a block 68 to sse if a per ½ pound key on the keyboard 13 has been closed for a count of three. If not, the logic jumps to a D4 input while if it has, the factor memory is set at a block 69 to two and the enter price flag is set. The output of the block 69 and the D4 input are applied to a block 70 at which a check is made to see if a per ¼ pound key on the keyboard 13 has been closed for a count of three. If not, the logic jumps to the D6 input while if it has, the factor memory is set to four at a block 71 and the enter price flag is set. The output of the block 71 and the D6 input are connected to a block 72 at which one of the static switches is checked to determine the selected jitter count and such count is loaded into a "required jitter count" memory. Although the required jitter count may be of any value, it is preferably either two or three. Thus, if the jitter count is three, the filtered weight and a raw or gross weight from the scale 11 must differ by a predetermined small amount for three consecutive counts or scans. From the block 72, a check is made at a block 73 to see if six scans have been made of the keyboard 13. If not, a fourteen millisecond delay is executed at a block 74 and the logic returns to the A3 input. If six scans have been executed, a check is made at a block 75 to see if this point in the logic has been arrived at by way of a block 165 in FIG. 2J and the A2 input in FIG. 2A. If not, the logic jumps to an H1 input, while if it has, the logic jumps to an E1 input.

The E1 input is connected to a block 80 in FIG. 2E at which a latch command is outputed to the scale 11, permitting weight data to be supplied from the scale 11 to the interface and input data multiplexer 12. After a latch command is applied to the scale 11, the weight digits are read from the scale 11 at a block 81. The scale 11 is preferably either of a mechanical spring type with an optical encoding chart or of an electronic load cell type including an analog-to-digital converter. In the mechanical spring type scale, the optical encoding chart typically provides weight data digitized in a Gray code format while an electronic load cell scale and analog-to-digital converter will provide weight data digitized in a binary coded decimal (BCD) format. For the following description, it will be assumed that the scale 11 is of the mechanical spring type with an optical Gray code encoding chart. Thus, the weight digits are read in the Gray code at the block 81. After the weight is read, the Gray code is converted to a BCD format and the weight digits are stored in a "raw weight" memory at a block 82.

For apparatus 10 used in a delicatessen, a Gray code chart reading up to 25.14 pounds is generally more than adequate. This requires fourteen columns on the Gray code chart. For greater weight readings, additional columns are required on the chart. A check is now made at a block 83 to see if the raw weight has exceeded the capacity of the Gray code chart or, in this case, if the weight has exceeded 25.14 pounds. If so, a print flag is cleared at a block 84, if such flag has previously been set, to abort a printing operation and the logic proceeds to an I15 input. If the weight capacity of the scale 11 has not been exceeded, a check is made at a block 85 to see if the contents of the raw weight memory are minus. If not, the logic jumps to an E7 input, while if the contents are minus, a check is made at a block 86 to see if all weight digits in the raw weight memory are equal to 0. If the digits are all equal to 0, the block 86 and the E7 input are connected to a block 87 at which the "raw weight minus sign" memory is cleared. If they are not all equal to 0, the raw weight minus sign memory is set at a block 88. The outputs of the blocks 87 and 88 are connected to a block 89 at which a "factor light" memory which energizes an indicator light on the digital display 17 is updated. From the block 89, logic proceeds to an F1 output.

Referring to FIG. 2F, the F1 input is connected to a block 94 at which the new weight data from the scale 11 stored in the raw weight memory is subtracted from the filtered weight stored in a "filtered weight" memory. If the difference between the two weights is 0, then the weight reading has not changed. A check is made at a block 95 to see if the difference is 0. If so, a "current jitter" counter is cleared or reset to zero at a block 96 and the logic jumps to the G1 input. If the difference is non-zero, a check is made at a block 97 to see if the motion band is one or two least significant weight digits, as determined by the setting of a motion band switch in the static or internal switches. If, for example, the static switch is set to a motion band of two, the new or raw weight from the scale 11 is permitted to deviate from the filtered weight by one or two least significant digits without generating a motion signal. This minor deviation is what has been referred to as "jitter," if rapidly alternating between successive weight values.

From the block 97, the difference between the new or raw weight and the filtered weight is compared with the motion band at a block 98. If the difference is outside the band, the logic jumps to a G7 input, while if it is within the band a "current jitter" counter is incremented up by one at a block 99. A check is then made at a block 100 to see if a change has occurred in the sign of the result obtained when the new or raw weight was subtracted from the filtered weight at the block 94. If not, the logic jumps to an F8 input, while if it has, the current jitter counter is cleared at a block 101. This prevents revising or updating the filtered weight when the raw weight is oscillating about the filtered weight within the permissible motion band. The block 101 and the F8 input are connected to a block 102 at which the stored sign of the result from block 94 is updated. At a block 103, the required jitter count, as determined by the setting of one of the static switches, is subtracted from the current jitter count stored in the counter. A check is then made at a block 104 to see if the result is equal to zero. If so, the logic jumps to a G8 input, while if it is not equal to zero, the logic proceeds to the G1 input.

The G1 input is connected to a block 109 in FIG. 2G. The sign of the raw or new weight from the scale 11 is compared here with the sign of the filtered weight. A check is then made at a block 110 to see if the signs are the same. If they differ, the logic jumps to the G8 input while if they are the same, a check is made at a block 111 to see if a motion flag is clear. If the motion flag is not clear, a "current hit" counter is incremented at a block 112 and, subsequently, a check is made at a block 113 to see if the contents of the current hit counter equals two. If the count does equal two, the motion flag is cleared at a block 114 and the logic proceeds to the G7 input.

The G7 input is connected to a block **115** at which the current hit counter is cleared and the motion flag is set. The output of the block **115** and the G8 input are connected to a block **116** at which the contents of the raw weight memory are moved to the filtered weight memory for use by the arithmetic logic unit **15** in computing a net weight and an article value, unless motion is present. From the block **116**, the raw weight sign is moved to a memory location for the filtered raw weight sign at a block **117** and the logic proceeds to a block **118**. The logic also proceeds to the block **118** from the block **111** if the motion flag was clear at this point and from the block **113** if the current hit count did not equal two. At the block **118** a check is made to see if the digital tare timer, which was actuated by pushing any of the digit keys on the keyboard **13**, has timed out. If the timer is on, the logic returns to A2 while if it has timed out, the digital tare memory is cleared at a block **119** and then the logic returns to the A2 input.

Returning for a moment to FIG. 2D, it will be noted that the block **75** has an output to an H1 input. Turning now to FIG. 2H, the H1 input is connected to a block **124** at which the tare weight stored in the tare memory is subtracted from the filtered weight stored in the filtered weight memory and the resulting net weight is stored in a "weight output" memory. A block **125** then checks to see if the apparatus **10** is in a prepack mode, as determined by a switch on the keyboard **13**. If the prepack mode has been selected, the logic proceeds to an H6 input to prevent automatic clearing of the apparatus **10** after each successive article is weighed. If the apparatus **10** is not in the prepack mode, a check is made at a block **126** to see if one of the static or internal switches is set to disable the "0.1 pound clear" circuitry which automatically causes the apparatus **10** to be cleared when an article is removed from the scale **11**. If so, the logic again proceeds to the H6 input, while if not a check is made at a block **127** to see if the net weight stored in the weight output memory is less than 0.1 pound. If the net weight is less than 0.1 pound, a check is made at a block **128** to see if a register or memory for the 0.1 pound flag contains the number five. If so, the logic returns to the A1 input for recycling the apparatus **10**. If not, the 0.1 pound flag is cleared at a block **129**. If the weight was not less than 0.1 pound at the block **127**, then the 0.1 pound flag is incremented at a block **130** to 5 at 200 millisecond intervals to note a one second time delay. The outputs of the blocks **129** and **130** and the H6 input are connected to a block **131** at which a check is made to see if one of the static switches is set to enable entry of tare weights. If not, the logic proceeds to an I1 input while if tare weight entry is enabled, a check is made at a block **132** to see if another static switch is set to make a tare weight entry mandatory. If the tare weight entry is not mandatory, the logic proceeds to the I1 input, while if it is mandatory a check is made at a block **133** to see if the tare done flag is set. If the flag is not set, the logic proceeds to a J8 input, while if it is set it proceeds to the I1 input.

The I1 input is connected to a block **138** in FIG. 2I. At the block **138**, a check is made to see if one of the static switches is set to require closure of a factor key when price data is entered. If a factor key must be closed, a check is made at a block **139** to see if a factor key has been pressed on the keyboard **13**. If none has been pressed, the logic jumps to the J8 input while if one has been pressed, a check is made at a block **140** to see if the enter price flag has been set. If the flag is not set, the logic jumps to an I8 input, while if it has been set the enter price flag is cleared at a block **141**. The block **141** and the I5 input are connected to a block **142** at which the contents of the price per pound memory are moved to the output memory. The price per pound memory is then cleared **at a block 143 and** the logic proceeds to the I8 input.

If a factor key was not required at the block **138**, the contents of the price per pound memory was moved to the output memory at a block **144**. The block **144** and the I8 input are then connected to a block **145** at which a check is made to see if the net weight is minus. If the net weight is minus, the logic proceeds to the J8 input while if it is not minus, a check is made at a block **146** to see if the factor stored in the factor memory is equal to 0. If so, the logic proceeds to an I11 input. If the factor was not equal to 0, the factor stored in the factor memory is multiplied times the entered price at a block **147** to obtain an actual price per pound. The block **147** is connected along with the I11 input to a block **148** wherein the actual price per pound is multiplied times the net weight. This result is rounded off at a block **149**. The rounded off final result is then stored in a "value output" memory at a block **150**. A check is then made at a block **151** to see if the "motion" flag is set. If not, the logic proceeds to a J1 input. If the motion flag is set or if the logic has jumped to the I15 input, the weight output memory is blanked at a block **152**. From the block **152** or if the logic has jumped to the I16 input, the "value output" memory is set to 0 at a block **153**. The logic then proceeds to a J4 input.

Turning to FIG. 2J, the J1 input is connected to a block **158** wherein a check is made to see if the computed value stored in the value output memory is less than $99.99. If it is greater than $99.99, the capacity of the digital display **17** and the capacity of the printer **18** are exceeded and a block **159** clears the print flag to abort a printing operation. The J8 input is also connected to the block **159** for aborting the printing operation. After the printing operation is aborted, the logic returns to the I16 input. If the value is not greater than $99.99 at the block **158**, a check is made at a block **160** to see if the print flag is set. If not, the logic jumps to a J4 input, while if it is set, a "print command" signal is supplied to the printer **18** and the print flag is cleared at a block **161**. The output of the block **161** and the J4 input are connected to a block **162** wherein a check is made to see if the printer is in the process of printing a label. If so, the logic proceeds to a J7 input, while if the printer is not in the process of printing a label, data is outputed from the output memories to the display and the printer at a block **163**. Data is also outputed to various indicator lights on the digital display **17** at a block **164**. The J7 input and the output of the block **164** are connected to a block **165** at which the print command signal is cleared and the logic then returns to the A2 input on FIG. 2A. This completes the operating sequence for the apparatus **10** for weighing and computing a value for articles.

The remaining drawings are concerned with details of the apparatus **10** for weighing and computing a value for articles and of modified embodiments of different portions of the invention. The scale **11** for generating digital gross or raw weight signals is preferably either of a mechanical spring type with an optical encoding chart or of a load cell type including an analog-to-digital converter. When the scale 11 is of the load cell type, it may be of the type disclosed in U.S. Pat. No. 3,709,309 which issued on January 9, 1973 to Roger B. Williams, Jr. et al., and the disclosure of such patent is incorporated herein. In a mechanical spring scale, an encoding chart is mounted to move with a platter or platform on which an article is placed. The encoding chart includes a plurality of columns for generating a non-ambiguous code, such as a cyclic Gray code. A translator having a plurality of photocells is positioned adjacent one side of the Gray code chart while a light source is positioned on the opposite side of the chart. As the chart is moved by a weight placed on the scale platter, the weight output is applied to the interface and input data multiplexer 12.

Turning now to FIG. 3, details are shown of a translator 170 for reading an optical Gray code encoding chart in a mechanical spring scale and converting the Gray code to a BCD format. The translator 170 includes 14 photocells 171*a* through 171*n* for reading fourteen annular columns of transparent and opaque areas on the Gray code chart. A photocell 172 is also provided for continuously sensing the output of a light source which energizes the photocells 171*a* through 171*n*. The photocell 172 provides a reference voltage which will depend upon the light level. All fifteen photocells 171*a* through 171*n* and 172 are connected to a positive bus 173 which is connected to a conventional regulated DC power supply. The bus 173 is also connected through a fixed resistor 174 to an electrical ground. The other end of each photocell 171*a* through 171*n* is connected through a potentiometer 175*a* through 175*n*, respectively, to a bus 176. The output of an operational amplifier 201 is also connected to the bus 176. The negative input to the amplifier 201 is connected to the bus 173 and also through a resistor 202 to the bus 176. The positive input to the amplifier 201 is connected through a resistor 203 to ground. The amplifier 201 regulates the voltage on the bus 176 with respect to the voltage on the bus 173. The junction between each of the photocells 171 and the connected potentiometer 175 is connected to the tap on such potentiometer 175 and also to a positive input to an associated one of fourteen comparators 177*a* through 177*n*. Thus, each of the potentiometers 175*a* through 175*n* is connected as a variable resistor between the photocells 171*a* through 171*n*, respectively, to the bus 176 for calibration purposes. The compensation photocell 172 is also connected through a potentiometer 178 connected as a variable resistor to the bus 176. The junction between the compensation photocell 172 and the potentiometer 178 is connected through a fixed resistor 179 and an operational amplifier 180 to a bus 181 which is connected in common to the negative inputs of the comparators 177*a* through 177*n*. A resistor 182 is connected between the bus 181 and a negative input to the operational amplifier 180. The resistors 179 and 182 determine the amplification factor of the amplifier 180. Thus, the comparators 177*a* through 177*n* continuously compare a reference voltage on the bus 181 with the outputs from the photocells 171*a* through 171*n*, respectively.

When an article is placed on a weighing platform on the scale 11, the encoding chart is moved to cause the signals applied from the photocells 171*a* through 171*n* to the comparators 177*a* through 177*n* to vary in a cyclic pattern until a steady state or balanced position is reached. In the balanced position, the comparators 177*a* through 177*n* will have outputs corresponding to the weight of the article. The outputs of the comparators 177*a* through 177*n* are connected to inputs of four shift registers 183-186 which provide a parallel-to-serial conversion of the Gray code. When a weight reading is to be stored in the memories 16, the data processor 14 and the interface 12 apply a latch signal on a terminal 187 which is connected through an RC delay network, including a series resistor 188 and a capacitor 188' connected to ground, and an inverter 189 to latch inputs on the four shift registers 183-186. The data processor 14 and interface 12 then apply clock signals on a terminal 190 which is connected through an RC delay network, including a series resistor 191 and a capacitor 191' connected to ground, and an inverter 192 in parallel to clock inputs on the four shift registers 183-186. The shift resister 183 has an output connected through an inverter 193 to a "one's" output line 194, the shift register 184 has an output connected through an inverter 195 to a "two's" output line 196, the shift register 185 has an output connected through an inverter 197 to a "four's" output line 198 and the shift register 186 has an output connected through an inverter 199 to an "eight's" output line 200. When the shift registers 183-186 are latched and, subsequently, clocked, Gray code digits of weight data are shifted in series on the output lines 194, 196, 198 and 200 which are connected to the interface and input data multiplexer 12.

It is desirable for an operator of the apparatus 10 to have an indication that the scale 11 is properly zeroed. If the scale 11 is not zeroed, erroneous weight data will be supplied to the data processor 14, resulting in the computation of an incorrect value for a weighed article. A zero sensor 204 is connected to the two photocells 171*a* and 171*b*. The columns on the code chart read by the photocells 171*a* and 171*b* change between transparent and opaque areas at plus and minus ¼ least significant weight graduation from a zero on the chart. The zero sensor 204 detects when the outputs of the photocells 171*a* and 171*b* indicates that the scale is within ¼ graduation of zero and applies a signal on a zero light data line 204'. This signal causes an indicator light to be illuminated, as will be discussed in greater detail below.

Referring now to FIG. 4, the keyboard 13 and the interface and input data multiplexer 12 are shown in detail. Four eight-line to one-line data selector/multiplexers 205-208 are connected to four processor data lines 209-212, respectively. Address data is supplied in parallel to the multiplexers 205-208 over three lines 213-215. Each of the multiplexers 205-208 has eight input lines. Corresponding ones of the eight input lines for each of the multiplexers 205-208 is connected to the output data lines 209-212, respectively, depending upon an address received from the data processor 14 on the lines 213-215. Although it is not shown, each of the inputs to the multiplexers 205-208 is connected through a separate resistor to a positive voltage source. The resistors have been eliminated from the drawing to simplify FIG. 4. Thus, the inputs to the multiplexers 205-208 are normally maintained at a high logic level and are grounded when data is received through the closure of a switch.

The keyboard 13 includes ten digit switches 216-225 which are normally open, momentary contact push button switches for selectively entering the digits zero through nine, respectively, into the data processor 14. The zeros digit switch 216 is connected to the first input line, the four digit switch 220 is connected to the second input line and the eight digit switch 224 is connected to the third input line to the multiplexer 205. The one digit switch 217 is connected to the first input line, the five digit switch 221 is connected to the second input line and the nine digit switch 225 is connected to the third input line to the multiplexer 206. The two digit switch 218 is connected to the first input line and the six digit switch 222 is connected to the second input line to the multiplexer 207. The three digit switch 219 and the seven digit switch 223 are connected to the first and second input lines to the multiplexer 208. The fourth input line to the multiplexer 205 is connected to a clear switch 226. The clear switch 226 is also connected through a Schmidt trigger 227 to apply a reset signal on a line 228 for clearing and resetting the data processor 14. The fourth input line to the multiplexer 206 is connected to a per 1 pound factor switch 229. The third input line to the multiplexer 207 is connected to a print switch 230 and the fourth input line is connected to a per ½ pound factor switch 231. The third input line to the multiplexer 208 is connected to a tare entry switch 232 and the fourth input line is connected to a per ¼ pound factor switch 233.

The fifth input lines to the multiplexers 205-208 are connected to the four weight data lines 194, 196, 198 and 200, respectively, from the scale 11. The sixth input line to the multiplexer 205 is connected to a tare required switch 234 which is mounted internal to the data processor 14. When a printer 18 is used with the apparatus 10, the printer is connected to apply a signal on a line 235 upon completion of a printing cycle. The line 235 is connected through a resistor 236 to ground and is also connected to the base of a transistor 237. The collector of the transistor 237 is connected to a positive voltage source while the emitter is connected through a resistor 238 to ground and is also connected to the seventh input line to the multiplexer 205. The transistor 237 maintains a continuous high voltage on the seventh input line to the multiplexer 205 when a printer is not connected to the line 235. The eighth and final input line to the multiplexer 205 is connected through a "tare enable" switch 239 which is mounted internal to the data processor 14. The setting of the switch 239 determines whether or not a tare weight can be entered into the apparatus 10. The sixth input line to the multiplexer 206 is connected to a "0.1 pound clear disable" switch 240. The setting of the switch 240 determines whether or not the memories 16 are cleared of price and tare weight data when an article is removed from the scale 11. The seventh input line to the multiplexer 206 is connected to a prepack mode switch 241 and also to a prepack mode data line 242. The eighth input line to the multiplexer 206 and also the eighth input lines to the multiplexers 207 and 208 are not used in the present embodiment of the apparatus 10.

The sixth input line to the multiplexer 207 is connected to a jitter count switch 243 which establishes a jitter count of two when the switch 243 is opened and a jitter count of three when the switch 243 is closed. Of course, the apparatus 10 may be modified so that other jitter counts can be established. The seventh input line to the multiplexer 207 is connected to an internal "digital tare enable" switch 244 which enables or disables manual entry of a tare weight through the digit keys 216-225 on the keyboard 13. The switch 244 does not affect automatic tare entry from the scale 11. The sixth input line to the multiplexer 208 is connected to a "motion band" switch 245. When the motion band switch 245 is open, the motion band is set at plus or minus one least significant weight digit while when the switch 245 is closed, the motion band is set at plus or minus two least significant weight digits. Finally, the seventh input line to the multiplexer 208 is connected to a "factor required" switch 246. When the factor required switch 246 is closed, one of the three factor switches 229, 231 or 233 must be closed before the apparatus 10 will compute and display a value for a weighed article. When the factor required switch 246 is opened or off, the apparatus 10 will assume that an entered price is a price per pound unless the price per ½ pound switch 231 is closed or the price per ¼ pound switch 233 is closed. The tare enable switch 239, the factor required switch 246, the tare required switch 234, the 0.1 pound clear disable switch 240, the jitter count switch 243, the motion band switch 245 and the digital tare enable switch 244 are each mounted internally to the data processor 14. These switches are provided for selecting various optional modes of operation for the apparatus 10. The switches may, for example, consist of rocker type switches which, when set, will remain in the set position. Normally, these switches will be set when the apparatus 10 is installed for a particular type of operation and thereafter will not need changing.

Data is supplied to the data processor 14 on the data lines 209-212 from the multiplexers 205-208, respectively, when the data processor provides address data on the lines 213-215. The address data on the lines 213-215 is modified by the data processor 14 to simultaneously scan corresponding ones of the eight input lines to the multiplexers 205-208. With the exception of the fifth input lines to the multiplexers 205-208, independent data is provided to the data processor 14 on each of the four data lines 209-212 indicative of various conditions or settings of switches. When the fifth input lines to the multiplexers 205-208 are addressed, the four weight data lines 194, 196, 198 and 200 from the scale 11 are connected to the processor data lines 209-212. At this time, the data processor 14 applies signals on the translator latch terminal 187 and clocks Gray code weight data by means of the translator clock terminal 190 through the multiplexers 205-208 to the processor data lines 209-212.

Referring now to FIG. 5, the data processor 14 and a portion of the interface 12 are shown in detail. The data processor 14 includes a central processing unit (CPU) 251, a random access memory (RAM) 252 and four read only memories (ROM) 253-256. The data processor 14 is preferably what is known in the art as a "microcomputer" or a "microprocessor" and is composed entirely of large scale integrated circuits. The data processor 14 may, for example, comprise a Model MCS-4 microcomputer set manufactured by Intel Corporation of Santa Clara, Calif. In such case, the CPU 251 would then be an Intel type 4004 integrated circuit, the RAM 252 would be an Intel type 4002 integrated circuit and the ROM's 253-256 each would be Intel type 4001 integrated circuits. However, it will be appreciated that other commercially available integrated circuit microcomputers will also operate in the apparatus 10 in accordance with the principles described herein.

The ROM's 253–256 store a fixed program for controlling the operating sequence of the apparatus 10. The program, which will be readily apparent to those of ordinary skill in the microcomputer programming art, causes data to be supplied to the CPU 251 for use in computing a net weight and a value for each weighed article and after a value is computed, supplies data to the display 17 and to a printer 18, when used. The data used by the microcomputer data processor 14 consists of data received on the lines 209–212 from the scale 11, from the keyboard 13 and from the printer 18. Four data and address outputs 257–260 from the RAM 252 are connected respectively through four inverters 261 to the three address lines 213–215 and to a data line 262. Address information and other data supplied from the RAM 252 to the address lines 213–215 controls data supplied to the data processor 14 and data supplied from the data processor 14 to the scale 11, to the digital display 17 and the printer 18. External data from, for example, the keyboard 13 and the scale 11 is supplied to the data processor 14 on the four data lines 209–212 which are connected to the ROM 253. At the proper time interval, the external input data on the lines 209–212 passes through the ROM 253 onto four input/output data busses 263 which are connected in parallel with the four ROM's 253–256, the RAM 252 and the CPU 251.

The data processor 14 also includes inputs for supplying the necessary operating voltages and clock signals. For example, the positive terminal from a 5-volt power source is connected to a bus 264 and the negative terminal of a 10-volt power source is connected to a bus 265, each of which are connected in parallel to the CPU 251, the RAM 252 and the ROM's 253–256. Clock pulses are also alternately supplied in parallel to the CPU 251, the RAM 252 and the ROM's 253–256 over two lines 266 and 267 which are connected to a conventional two-phase, non-overlapping clock pulse source. The data input lines 209–212 to the ROM 253 are each connected through a resistor 268 to the positive terminal of a 5-volt source. Thus, the input lines 209–212 are normally maintained positive and selectively become negative when data is received from the interface and multiplexer 12. Output data from the data processor 14 is supplied from the RAM 252 and the ROM's 254 and 255. Each of the output terminals from the RAM 252 and the ROM's 254 and 255 are connected through a resistor 269 to the negative terminal 265.

After input data is supplied on the lines 209–212 to the data processor 14, a net weight is computed and, from the net weight and an entered price per unit weight, a value is computed. The net weight and value are computed using conventional digital techniques. After the computation is completed, data is outputed from the data processor 14. In addition to input data address information, the RAM 252 also outputs other data on the outputs 257–259. The output 257 is connected through one of the inverters 261 to three parallel bistable latches 270–272. The output 258 from the RAM 252 is connected through one of the inverters 261 to three parallel bistable latches 273–275. The output 259 from the RAM 252 is connected through one of the inverters 261 to a bistable latch 276. As previously discussed, the address lines 213–215 are also connected to the outputs of the inverters 261 connected to the outputs 257–259 from the ROM 253. The fourth data output 260 from the RAM 252 is connected through a fourth of the inverters 261 and the line 262 to two bistable latches 277 and 278. The ROM 254 has an output 279 which is connected through an inverter 280 to a line 281 for simultaneously strobing the bistable latches 270, 273, 276 and 277. When the latches 270, 273, 276 and 277 are strobed, they take on one of two logic states determined by the current outputs from the RAM's 252. A second output 282 from the ROM 254 is connected through an inverter 283 for strobing the bistable latches 271, 274 and 278. When a strobe signal is applied to these latches, the outputs 257, 258 and 260 from the RAM 252 are stored, respectively, in the latches 271, 274 and 278. The ROM 254 has a third output 284 which is connected through an inverter 285 to strobe the bistable latches 272 and 275 to store, respectively, data appearing on the outputs 257 and 258 from the RAM 252. At the same time, the output from the inverter 285 strobes a bistable latch 286 to store data on the zero light data line 204' (From FIG. 3). The bistable latches are commercially available in an integrated circuit form typically with four latches in a package. Therefore, the output from the inverter 283 also strobes a spare bistable latch 286 and the output from the inverter 285 strobes a spare bistable latch 288. The spare bistable latches 286–288 may be used for storing additional output data in modified embodiments of the apparatus 10.

The ROM 254 also has a fourth output 289 which is connected through an inverter 290 to an output terminal 291 for supplying clock pulses to clock data to the digital display 17. The output from the inverter 290 is also connected through an amplifier 292 to a terminal 293 for simultaneously supplying clock pulses to the printer 18 and is connected through an inverter 294 to the translator clock terminal 190 for clocking weight data from the scale 11 to the multiplexers 205–208 in FIG. 4 when the translator 170 is latched. The ROM 255 supplies tare weight, price per unit weight, net weight and computed value data from the data processor 14 to the digital display 17 and to the optional printer 18. The ROM 255 has four outputs 295–298 which are connected through four inverters 299 to output terminals 300–303 for sequentially supplying output data in a BCD format to the digital display 17. The outputs 300–303 are also connected through four amplifiers 304 to corresponding outputs 300' through 303' for supplying the same data to the printer 18.

The remaining outputs for supplying data to the keyboard 13, the digital display 17 and the printer 18 are taken from the bistable latches 270–278 and 286. The bistable latch 270 has an output connected through an inverter 305 to a terminal 306 for supplying a signal to reset the printer 18. The bistable latch 273 has an output collected through an inverter 307 to a terminal 308 for supplying a signal to enable the printer 18 to read data on the data outputs 300' through 303' from the data processor 14. The bistable latch 276 has an output connected through an inverter 309 to a terminal 310 for enabling both the digital display 17 and the printer 18 to store data appearing on the outputs 300' through 303' as price and value data. The bistable latch 277 is connected through an inverter 311 to a terminal 312 for enabling both the digital display 17 and the printer 18 to recognize and store data appearing on the outputs 300' through 303' as weight data. The bistable latch 271 is connected through an inverter 313 to the translator latch terminal 187 for enabling data to be supplied from the scale 11 through the data multiplexers 205-208 to the data processor 14. The bistable latch 274 is connected through an inverter 314 to a terminal 315 for supplying a signal to command the printer 18 to print a label or other record of the data supplied from the data processor 14. The bistable latch 278 has an output connected through an inverter 316 to a terminal 317 for supplying a signal to the digital display 17 and the printer 18 when the weight data is negative. The bistable latch 272 has an output connected through an inverter 318 for applying a signal on a terminal 319 which illuminates a light on either the keyboard 13 or the display 17 to indicate when the weight factor has been set to per ½ pound by the switch 231. The bistable latch 275 has an output connected through an inverter 320 to a terminal 321 which is similarly connected to illuminate a per ¼ pound indicator light when the per ¼ pound factor switch 233 is actuated. The per ½ pound indicator light is preferably mounted within or adjacent the per ½ pound factor switch 231 and the per ¼ pound indicator light is preferably mounted within or adjacent the per ¼ pound factor switch 233 for indicating when the apparatus 10 is operated in either of these modes. The bistable latch 287 is connected through an inverter 322 to a terminal 323 for illuminating a zero light when the scale 11 is properly zeroed.

Referring now to FIG. 6, the digital display 17 is shown in detail. The digital display 17 includes eleven seven-segment indicators 330-340 which may be Numitrons or other conventional types having seven segments which are selectively illuminated by means of, for example, incandescent lamps, light emitting diodes or gas discharge tubes. The three indicators 330-332 indicate hundredths, tenths and units digits of price data ranging from $.01 up to $9.99. The four indicators 333-336 indicate hundredths, tenths, units and tens digits of weight data ranging from 0.01 pound up to the maximum capacity of the scale 11 which has previously been established as 25.14 pounds, the maximum capacity of the Gray code optical encoding chart in the scale 11. The remaining four indicators 337-340 indicate four digits of computed value in hundredths, tenths, units and tens digits, respectively, from $.01 up to $99.99.

Eleven BCD-to-seven-segment decoder/drivers 341-351 are connected, respectively, to selectively energize the segments in the 11 indicators 330-340. BCD data is supplied to the decoder/drivers 341-351 from eight series-to-parallel shift registers 352-359. The "ones" bits for the three price decoder/drivers 341-343 and the four value decoder/drivers 348-351 are stored in the shift register 352 and the four "ones" bits for the four weight decoder/drivers 344-347 are stored in the shift register 353. The three "twos" bits for the decoder/drivers 341-343 and the four "twos" bits for the value decoder/drivers 348-351 are stored in the register 354 and the four "twos" bits for the weight decoder/drivers 344-347 are stored in the register 355. The three "fours" bits for the price decoder/drivers 341-343 and the four "fours" bits for the value decoder/drivers 348-351 are stored in the register 356 and the four "fours" bits for the weight decoder/drivers 344-347 are stored in the register 357. Finally, the three "eights" bits for the price decoder/drivers 341-343 and the four "eights" bits for the value decoder/drivers 348-351 are stored in the shift register 358 and the four "eights" bits for the four weight decoder/drivers 344-347 are stored in the register 359. For simplicity, the 44 connections between the shift registers 352-359 and the decoder/drivers 341-351 have been omitted from FIG. 6.

The data output terminal 300, which receives the "ones" bits of BCD weight data from the data processor 14, is connected in parallel to inputs to the two shift registers 352 and 353. Similarly, the "twos" output terminal 301 from the data processor 14 is connected in parallel to the two shift registers 354 and 355, the "fours" output terminal 302 is connected in parallel to the two shift registers 356 and 357 and the "eights" output terminal 303 is connected in parallel to inputs to the two shift registers 358 and 359. The price/value enable terminal 310 (from FIG. 5) is connected in parallel to enable the four registers 352, 354, 356 and 358 which store the price and value data. The price/value enable terminal 310 is also connected to a NAND gate 360. The display data clock terminal 291 (from FIG. 5) is connected to a second input of the NAND gate 360. The output of the NAND gate 360 is connected through an inverter 361 to clock inputs on the registers 352, 354, 356 and 358. Thus, when the bistable latch 276 is set to apply a signal on the price/value enable terminal 310, price and value data is serially shifted into the registers 352, 354, 356 and 358. Similarly, the weight enable terminal 312 and the data clock terminal 291 are connected to a NAND gate 362. The output of the NAND gate 362 is connected through an inverter 363 to clock inputs on the weight shift registers 353, 355, 357 and 359 for shifting weight data from the data terminals 30-303 into such registers. Once stored in the registers 352-359, the price, weight and value data will be maintained until revised by the data processor 14. Therefore, this data will appear continuously on the indicators 330-340.

In some instances, the weight displayed on the indicators 333-336 will have a negative value. The weight will, for example, have a negative value when a tare weight has been manually entered through the keyboard 13 and an article has not yet been placed upon the scale 11. In this case, the entered tare weight will appear on the indicators 333-336. However, the negative weight will be limited to a relatively small value and in all cases will be no greater than 9.99 pounds. The tens weight indicator 336 is used for indicating the presence of a negative value. The minus sign terminal 317 (from FIG. 5) is connected to energize the tens weight indicator 336 to illuminate a minus sign, or the center one of the seven segments.

As previously discussed, the actuation of the tare entry key 232 on the keyboard 13 causes either a digital tare weight entered manually through the digit keys 216-225 to be stored in the digital memories 16 or, if one or more of the digit keys 216-225 has not been actuated within a predetermined time interval of actuation of the tare entry key 232, a weight from the scale 11 is automatically entered or stored in the memories 16. For an automatic entry of tare weight, the article container is initially placed on the scale 11 and the weight of such container will appear on the weight indicators 333–336. When the tare entry key is pushed, the displayed weight is stored as a tare weight. The net weight is subsequently calculated by the data processor 14 and such net weight is stored in the shift registers 353, 355, 357, and 359 for display on the weight indicators 333–336. Since the weight of the empty container on the scale 11 and the tare weight are identical, the net weight will now be 0 and a series of zeros will appear on each of the indicators 333–336. Of course, the computed value will also be 0 since the net weight is 0 and the value indicators 337–340 will also display zeros. When a price or tare weight number is entered through the digit keys 216–225 on the keyboard 13, such number appears on the price indicators 330–332. If the tare entry key 232 is then actuated before the predetermined time interval has elapsed, one or more of the digits shown on the price display are shifted into the tare memory, clearing the price memory, and the tare weight will appear as a negative quantity on the weight indicators 333–336, unless an article is on the scale in which case a net weight is displayed. Or, when an article is subsequently placed in a container and on the scale 11, a net weight will be computed and displayed on the weight indicators 333–336. In many cases, it is only necessary to have a tare weight ranging from .01 pound up to .09 pound. In such case, only the digit appearing on the least significant price indicator, or the hundredths price indicator 330, is shifted into the hundredths position of the tare weight memory for display on the hundredths pound indicator 333.

The system or method for entering tare weight has been described above embodied in specific apparatus 10 which includes an integrated circuit microcomputer. However, the system for manually and automatically entering tare weight may also be used with other types of scales which require a tare weight for measuring net weights. Turning now to FIG. 7, a modified embodiment is shown of apparatus 370 for entering a tare weight into a scale system either manually from a digital keyboard or automatically from the scale itself. The scale in which the apparatus 370 is used includes four 4-bit registers 371–374 for storing in a BCD format four weight digits. The register 371 stores the hundredths or .0W gross weight digit, the register 372 stores the tenths or .W gross weight digit, the register 373 stores the units or W. gross weight digit and the register 374 stores the tens or W0. gross weight digit as measured by the scale. The scale also includes four 4-bit registers 375–378 for storing four digits of tare weight. The register 375 stores the hundredths or .0T digit, the register 376 stores the tenths of a .T digit, the register 377 stores the units or T. digit and the register 378 stores the tens or T0. digit of the tare weight. The scale is then provided with any conventional means for computing a net weight from the gross weight stored in the registers 371–374 and the tare weight stored in the registers 375–378.

The apparatus 370 is sequenced by means of a clock 379. The clock 379 is provided with four outputs which have four-phase and non-overlapping pulse trains. The pulse trains will hereinafter be referred to as $\phi 1$ through $\phi 4$. The clock pulses in the four phases $\phi 1$ – $\phi 4$ may, for example, each have a 2 microsecond pulse width and be repeated each 16 microseconds. The pulses for the successive phases are delayed by 2 microseconds from the previous phase so that they are non-overlapping.

A keyboard (not shown) is provided with a tare entry key having an output connected through an inverter 380 to a terminal 380′ and with nine digit keys having outputs connected to nine digit inputs 381. The tare entry key and the digit keys are normally maintained at a high voltage level and ground the appropriate inputs to the apparatus 370 when closed. When one of the digit keys is pushed, a signal is applied over the corresponding input 381 to an OR gate 382 which starts a monostable or one shot multivibrator 383. Once started, the multivibrator 383 remains on for a predetermined time interval, such as 1.6 seconds, and subsequently shuts off. While on, the multivibrator 383 has a high Q_T output and a low $\overline{Q}_T$ output and when off, the multivibrator 383 has a low Q_T output and a high $\overline{Q}_T$ output. At the same time a signal on one of the digit inputs 381 triggers the multivibrator 383, the signal is applied to a decimal-to-BCD encoder 384. The BCD output from the encoder 384 is applied to the input of a 4-bit digital tare memory 385. Before the multivibrator 383 is triggered by the actuation of a digit key, the low Q_T output holds a flip-flop 386 clear, resulting in a low Q_4 output and a high $\overline{Q}_4$ output and holds a flip-flop 388 clear, resulting in a low Q_3 output.

The apparatus 370 remains in the above state until the multivibrator 383 triggers, causing Q_T to go high and until the next $\phi 1$ clock pulse, which causes a NAND gate 387 to set the flip-flop 388 to have a high Q_3 output. The Q_3 output is applied to an AND gate 389 and to a NAND gate 390. Upon the occurrence of the next clock pulse, which is a $\phi 2$ pulse, the NAND gate 390 produces an output for setting the flip-flop 386 to produce a high Q_4 output. The high Q_3 and Q_4 outputs are applied to the AND gate 389 which strobes the digital tare memory 385, thereby storing the BCD equivalent of the energized digit input 381 from the keyboard. Upon occurrence of the $\phi 3$ pulse, a NAND gate 391, which has a second input connected to the high Q_4 output from the flip-flop 386, applies a pulse to a OR gate 392 for clearing the flip-flop 388, thereby removing the strobe signal from the memory 385. The OR gate 392 also has an input from the Q_T output of the multivibrator 383. The clock 379 will continue to cycle without further effect until either the tare entry key is pushed or the multivibrator 383 has timed out.

When the tare entry key is pushed to apply a signal on the input terminal 380′, the apparatus 370 is sequenced to shift either the digit stored in the memory 385 into the .0T tare weight register 375, if the multivibrator 383 is on, or to shift the contents of the gross weight registers 371–374 into the tare weight registers 375–378, respectively. While the tare entry key is open, the output from the inverter 380 maintains flip-flops 393 and 395 clear such that the flip-flop 393 has a high $\overline{Q}_1$ output and a low Q_1 output and the flip-flop 395 has a high $\overline{Q}_2$ output and a low Q_2 output. When the tare entry key is closed to ground the input to the inverter 380, the next $\phi 1$ clock pulse sets the flip-flop 395. The Q_2 output from the flip-flop 395 and the $\overline{Q}_1$ output from the flip-flop 393, both of which are now high, are applied to an AND gate 396. The next $\phi 2$ clock pulse then passes through the gate 396 to clear the tare weight registers 376–378. The high Q_2 output from the flip-flop 395 also enables a NAND gate 397 so that the next $\phi 3$ clock pulse sets the flip-flop 393 to a high Q_1 output and a low $\overline{Q}_1$ output. The now high Q_1 and Q_2 outputs from the flip-flops 393 and 395, respectively, pass through an AND gate 398 to enable three AND gates 399, 400 and 414. The AND gate 399 has a second input connected to the Q_T output of the multivibrator 383 and the AND gate 400 has a second input connected to the $\bar{Q}_T$ output from the multivibrator 383. Assuming that a digital tare weight has been entered from a keyboard and the multivibrator 383 is still on, the AND gate 399 will now apply a signal in parallel to enable four AND gates 401–404. When the AND gates 401–404 are enabled by an output from the AND gate 399, the four bits of the BCD tare weight digit stored in the memory 385 pass through the AND gates 401–404 and through four OR gates 405–408 to inputs to the tare weight register 375.

If either a digit has not been entered on one of the nine digit inputs 381 to turn on the multivibrator 383 or if the multivibrator 383 has timed out, the multivibrator 383 will apply a high $\bar{Q}_T$ output to the AND gate 400. When the AND gate 398 applies a signal to the second input of the AND gate 400, the AND gate 400 enables four AND gates 409–412. When the AND gates 409–412 are enabled, the .0W or hundredths weight digit from the gross weight register 371 is passed through the OR gates 405–408 to the input to the hundredths tare weight register 375. The output of the AND gate 400 is also connected to an AND gate 413. Upon the occurrence of a $\phi 4$ clock pulse, the output of the AND gate 398 and the clock pulse enable the AND gate 414 to produce an output for strobing the tare weight register 375. At this time, either the contents of the memory 385 or the register 371 are stored in the register 375, depending upon the state of the multivibrator 383. If the multivibrator 383 is not on so that the gate 400 has an output, the AND gate 413 simultaneously produces a clock pulse which strobes the tare weight registers 376–378. When the tare weight registers 375–378 are strobed, tare weight data is stored from the gross weight registers 372–374. As the clock 379 continues to cycle, the next pulse is a $\phi 1$ pulse. This clock pulse is passed through a NAND gate 415, which is enabled by the Q_1 output from the flip-flop 393, and an OR gate 416 to clear the flip-flop 395. When the flip-flop 395 is cleared, the high $\bar{Q}_2$ output and the high Q_1 output from the flip-flop 393 causes an AND gate 417 to generate an output which clears the digital tare memory 385. Then when the enter tare key is released, the low output 380' from the inverter 380 clears the flip-flop 393 and maintains the flip-flop 395 cleared. This completes the operating sequence of the apparatus 370. Although the apparatus 370 has been provided with only a single memory 385 for storing only the hundredths digit of a tare weight manually entered from a keyboard, it will be appreciated that the apparatus may be readily adapted for manually entering additional digits of tare weight.

The system or method for digitally filtering the weight data received from the scale 11 has also been described above in a specific embodiment of the apparatus 10. However, it will be appreciated that the digital filtering technique may be adapted for use in scales which do not include an integrated circuit microcomputer and may also be adapted for filtering digital data entered into other types of digital systems besides scales and weight measuring apparatus. Referring now to FIG. 8, a modified embodiment is shown of apparatus 425 for filtering digital data in accordance with the above-described embodiment of the invention. The filtering operation is controlled by means of a four-phase clock 426 which generates four sequential, non-overlapping clock outputs ϕ_1 through ϕ_4. During the first clock pulse on the ϕ_1 output of the clock 426, new or raw data is clocked into a four-bit storage register 427. The new data stored within the register 427 is applied to the input of a filtered data register 428 and also to an "A" input of a comparator 429. The filtered data presently stored within the register 428 is applied in parallel to a "B" input to the comparator 429 and also to four filtered data output lines 430.

The comparator 429 compares the A and B inputs using conventional digital logic circuitry. If the difference between the A and B inputs is greater than 1, the comparator applies a signal on an output 431. If the difference between the A and B inputs is equal to one, the comparator 429 applies a signal on a second output 432. If the A and B inputs are equal, the comparator 429 applies a signal on a third output 433. The comparator 429 also has an output 434 which indicates the sign of the difference between A and B. If A is greater than or equal to B, a signal will be applied by the comparator 429 on the output 434. If A is less than B, no signal will be applied on the output 434.

After the ϕ_1 clock pulse is applied to store the raw weight data in the register 427, a ϕ_2 clock pulse is applied to enable four AND gates 435–438. The output 431 from the comparator 429 is connected to the second input of the gate 435. If the difference between A and B inputs to the comparator 429 is greater than one, the signal applied on the output 431 passes through the AND gate 435 and an OR gate 439 to clock the new data stored in the register 427 into the filtered data register 428. The clock output from the OR gate 439 also passes through a delay circuit 440 and an OR gate 441 to clear a counter 442. If, on the other hand, the difference between A and B is equal to one, the comparator 429 applies a signal on the output 432 which passes through the enabled AND gate 436 to increment the counter 442. If A is equal to B, the comparator 429 applies a signal on the output 433 which passes through the enabled AND gate 437 and the OR gate 441 to clear the counter 442. The sign output 434 from the comparator 429 is applied to one input of an exclusive OR gate 443. The second input to the exclusive OR gate 443 is connected to the Q output of a flip-flop 444. The flip-flop is set in response to the ϕ_3 clock pulse to the true or false logic level of the sign output 434 from the comparator 429. Therefore, during the ϕ_2 clock pulse, the flip-flop 444 will have a logic state dependent upon the state of the output 434 from the comparator 429 during the previous cycle of the clock 426. If the output 434 from the comparator 429 changes logic levels, the exclusive OR gate 443 will apply a signal through the enabled AND gate 438 and the OR gate 441 to clear the counter 442.

The counter 442 has an output 445 connected to one input of an AND gate 446. The second input to the AND gate 446 is connected to the ϕ_4 output from the clock 426. The output 445 from the counter 442 has arbitrarily been selected as a count three output. Thus, a signal is applied on the output 442 whenever the counter 442 is incremented up to three. When the counter 442 is incremented to three to apply a signal on the output 445, the ϕ_4 clock pulse passes through the AND gate 446 and the OR gate 439 to clock the new data stored in the register 427 into the filtered data register **428**. The clock pulse also passes through the delay circuitry **440** and the OR gate **441** to clear the counter **442**.

From the above description, it will be noted that the new or raw data stored in the register **427** is permitted to fluctuate or jitter within plus or minus one of the filtered data stored in the register **428** without revising the filtered data during each cycle of the clock **426**. The filtered data stored within the register **428** is revised only when the contents of the registers **427** and **428** deviate by either one for three consecutive cycles of the clock **426** or by greater than one on one cycle of the clock **426**. If the contents of the register **427** oscillate alternately to plus and minus one digit of the contents of the filtered data register **428** or to the same value as is stored in the filtered data register **428**, then the counter **442** is cleared on each clock cycle so that the filtered data stored in the register **428** is not updated. It will be appreciated that the apparatus **425** may be adapted for use in entering weight readings from a scale into a filtered weight memory or for entering other types of digital data into memories with the elimination of jitter from the data. It will also be apparent that filtering band may be expanded to accommodate a wider jitter range merely by modifying the comparator **429**. For example, the outputs **431** and **432** may be generated, respectively, when $A - B$ is greater than ± 2 and when $A - B$ equals ± 1 or ± 2.

Although specific embodiments of the invention have been described above, it will be appreciated to those skilled in the art that various modifications and changes may be made without departing from the spirit and the scope of the claimed invention. Furthermore, it will be appreciated that in the broadest aspect of the claims, the invention may be adapted to various types of apparatus.

What we claim is:

1. A weighing and computing scale comprising, in combination, integrated circuit microcomputing means including an arithmetic logic unit, a sequence controller and data registers, weighing scale means for generating gross weight data, data input means having a plurality of digit keys for sequentially entering data into said weighing and computing scale, buffer and memory means for receiving tare weight data and gross weight data from said scale means and price data from said digit keys on said data input means and functioning as an interface with said arithmetic logic unit, said buffer and memory means receiving and storing tare weight data selectively from said scale means or said digit keys on said data input means, the tare weight data, the gross weight data and the price data being related to each of a plurality of successive weighed articles, and digital display means for visually indicating the price data, computed net weight data and value data computed from such data, said sequence controller causing said arithmetic logic unit and registers to compute the net weight and the value of the weighed articles and controlling the supplying of such computed net weight and value and the price data through said buffer and memory means to said display means.

2. A weighing and computing scale, as set forth in claim **1**, wherein said sequence controller includes means for causing said buffer and memory means to periodically scan said data input means for data, means for comparing data received from said data input means on successive scans, and means for causing said buffer and memory means to store price and tare weight data from said data input means only after such data is received on a predetermined number of successive scans.

3. A weighing and computing scale, as set forth in claim **1**, wherein said data input means includes a tare key, and including timing means for measuring a predetermined time interval, means responsive to the closure of any of said digit keys for starting said timing means to measure such predetermined time interval, means responsive to the closure of said tare key for causing said buffer and memory means to store a tare weight, such stored tare weight comprising data received from said digit keys when said tare key is closed while said timing means is on and comprising weight data received from said scale means when said tare key is closed while said timing means is off.

4. A weighing and computing scale, as set forth in claim **1**, and further including means for digitally filtering gross weight data from said weighing scale means to reduce jitter, and wherein the net weight is computed from the filtered gross weight data.

* * * * *

United States Patent [19]

Northcutt

[11] **3,967,690**

[45] **July 6, 1976**

[54] DIGITAL READOUT DIET SCALE

[75] Inventor: Michael E. Northcutt, Mountain View, Calif.

[73] Assignee: Aledyne Corporation, Los Altos, Calif.

[22] Filed: Jan. 7, 1975

[21] Appl. No.: 539,109

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 445,218, Feb. 25, 1974, abandoned.

[52] U.S. Cl. .... 177/25; 177/164; 177/245; 177/DIG. 3; 235/92 WT

[51] Int. Cl.² G01G 19/04; G01G 23/14; G06F 7/38

[58] Field of Search .... 177/25, 164, 165, 245, 177/DIG. 3; 235/92 WT, 151.33

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Primary Examiner—George H. Miller, Jr.

[57] ABSTRACT

An electronic digital readout diet scale including means for accurately detecting and displaying minute changes of weight in a dieter accurate to small fractions of pounds is described. One embodiment comprises a transducer for generating a signal representing the weight of the dieter, and means for storing a signal representing a reference weight for the dieter. These signals are applied to a time gated oscillator whose output in turn is applied to an up-down counter. The counter is responsive to the oscillator output signals to display the dieter's weight or change in weight, and provides a digital display of current weight or weight change. A switching device, either manual or automatic with a time delay, first couples the transducer output to the counter to display the current weight of a user and then couples the storage means to the counter to decrease the displayed weight by the reference weight, whereby the relative change of weight of the user may be displayed.

15 Claims, 6 Drawing Figures

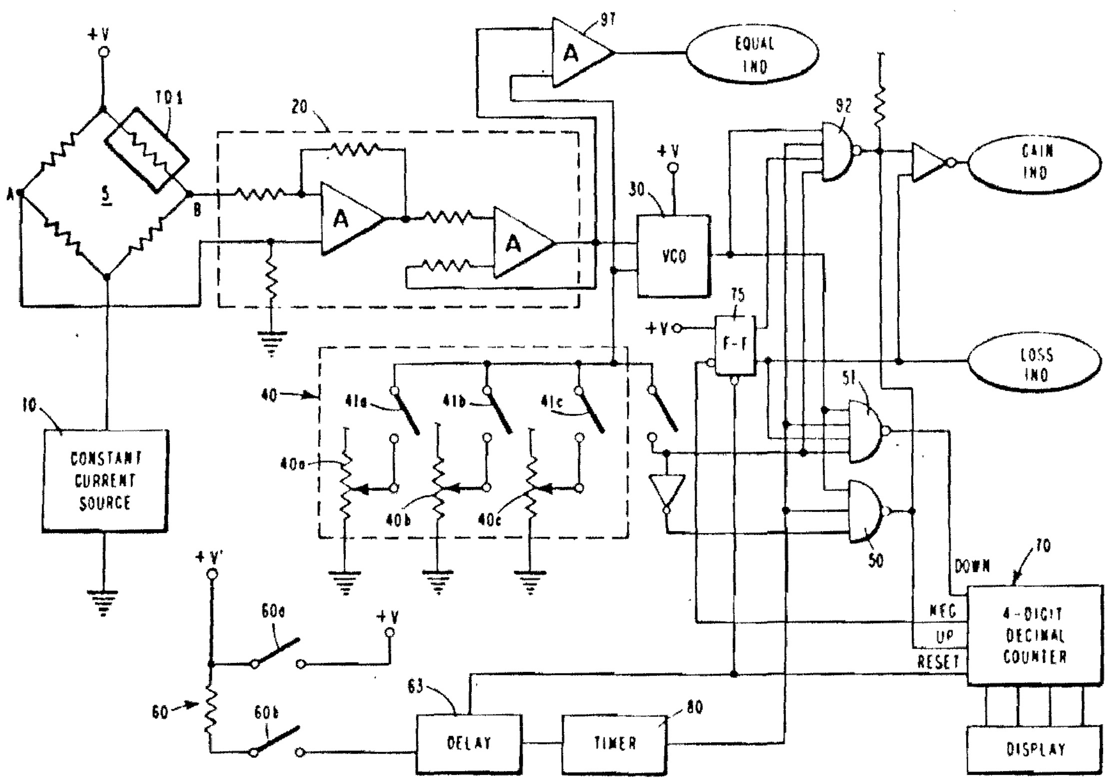
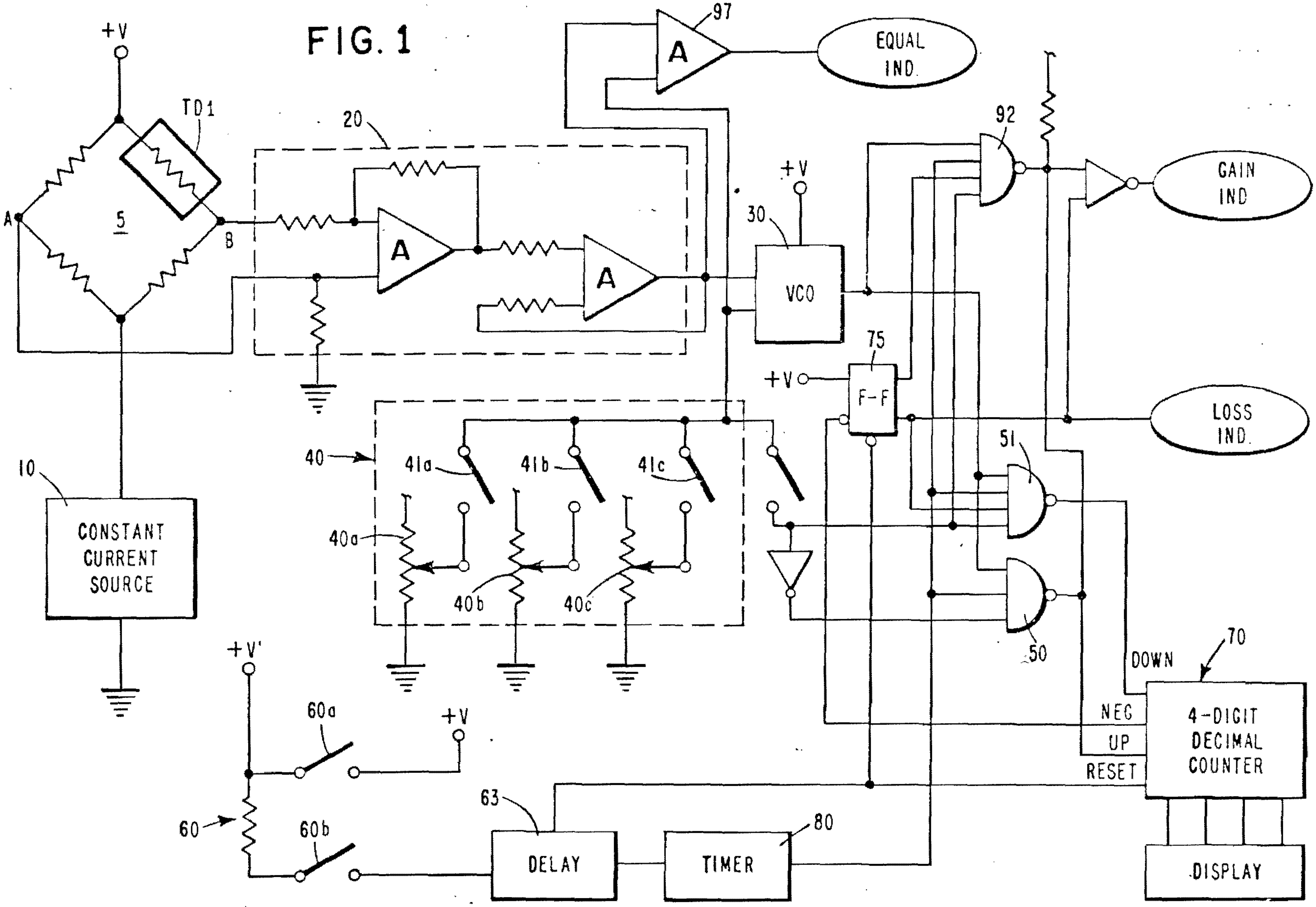


FIG. 1


+V
TD1
20
A
5
B
A
A
10
CONSTANT CURRENT SOURCE
97
A
EQUAL IND.
+V
30
VCO
92
GAIN IND
75
+V
F-F
LOSS IND.
40
41a
41b
41c
40a
40b
40c
51
50
DOWN
70
+V'
60a
+V
NEG
UP
RESET
4-DIGIT DECIMAL COUNTER
63
80
60
60b
DELAY
TIMER
DISPLAY

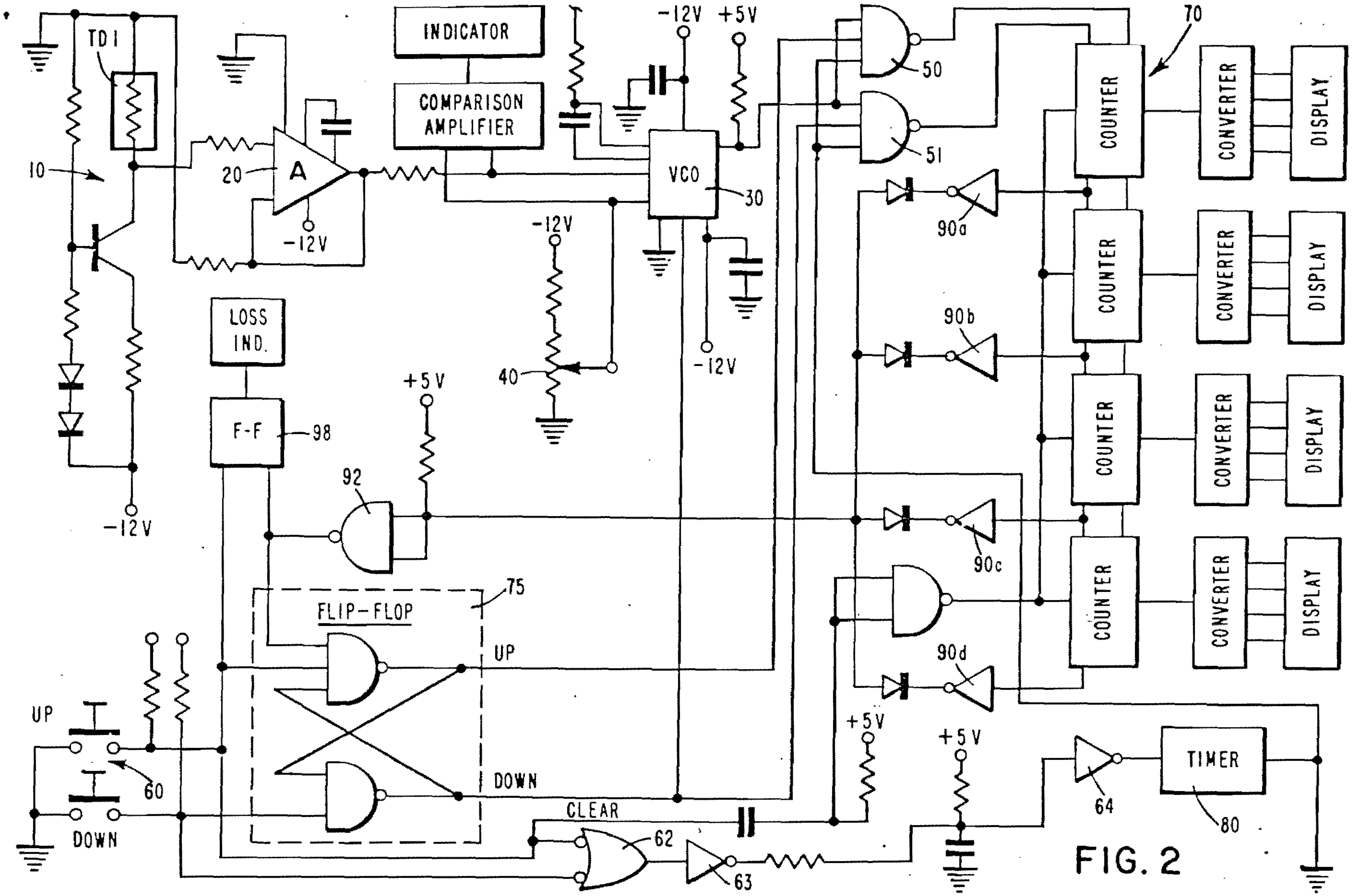

TD1
10
20
A
-12V
INDICATOR
COMPARISON AMPLIFIER
VCO
30
+5V
40
LOSS IND.
F-F
98
92
FLIP-FLOP
75
UP
DOWN
60
CLEAR
62
63
64
TIMER
80
50
51
70
COUNTER
CONVERTER
DISPLAY
90a
90b
90c
90d

FIG. 2

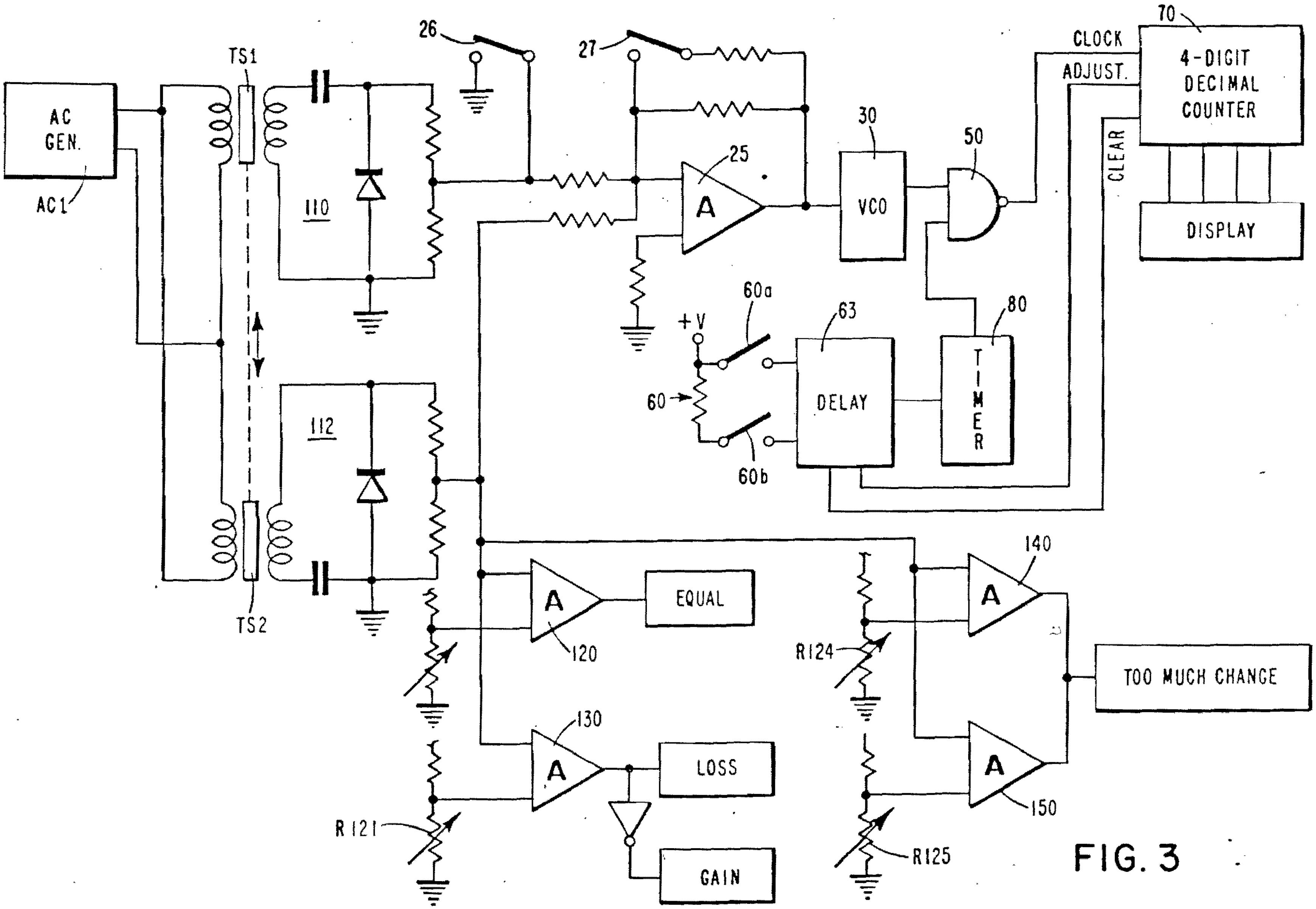
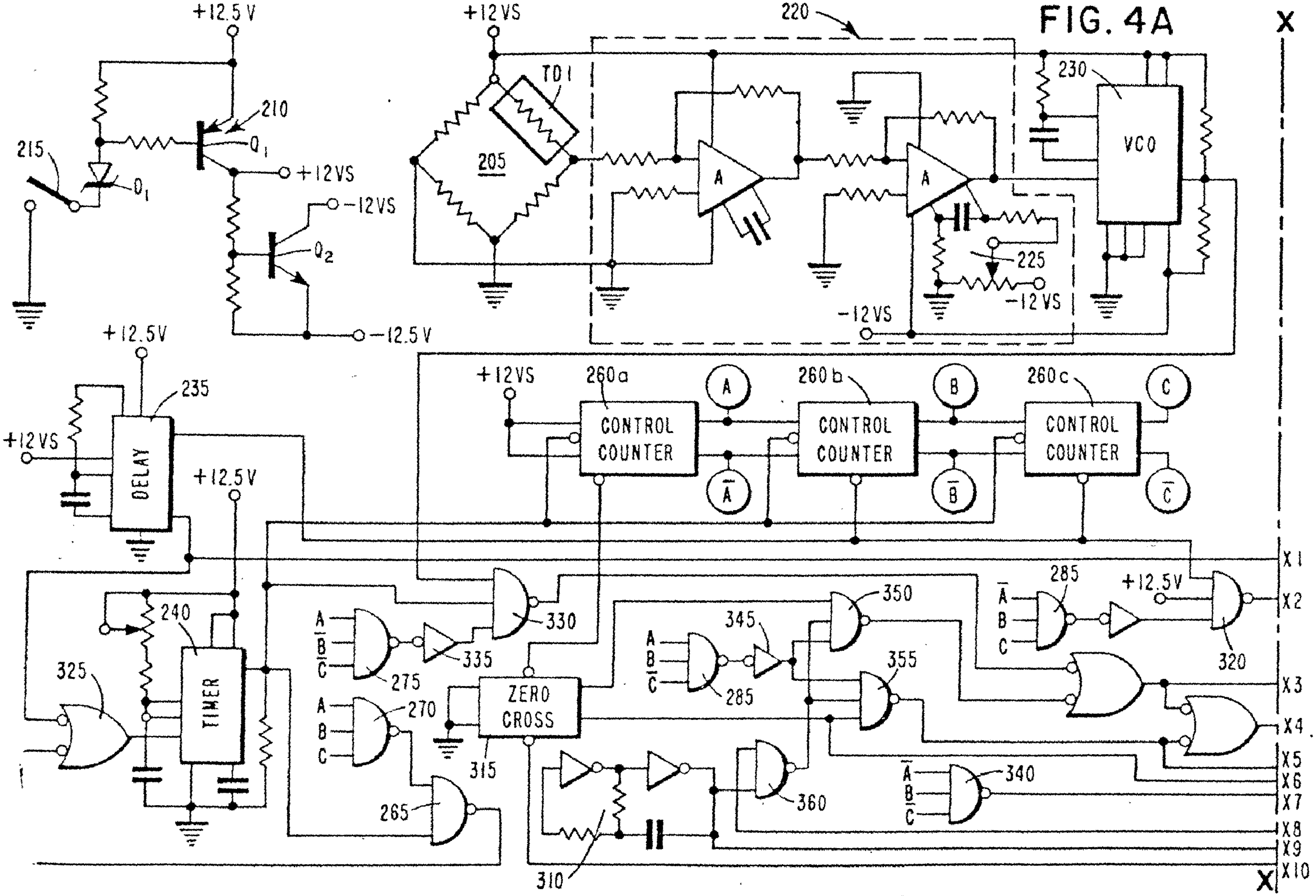

AC GEN.
AC1
TS1
TS2
110
112
26
27
25
A
30
VCO
50
70
CLOCK
ADJUST.
CLEAR
4-DIGIT DECIMAL COUNTER
DISPLAY
+V
60
60a
60b
63
DELAY
80
TIMER
120
EQUAL
130
LOSS
GAIN
R121
140
150
R124
R125
TOO MUCH CHANGE

FIG. 3

FIG. 4A


+12.5 V
210
Q1
215
D1
+12VS
-12VS
Q2
-12.5 V
+12VS
TD1
205
220
A
A
225
-12 VS
-12VS
230
VCO
X
+12.5V
235
DELAY
+12VS
+12.5V
240
TIMER
325
+12VS
260a
CONTROL COUNTER
260 b
CONTROL COUNTER
260c
CONTROL COUNTER
A
Ā
B
B̄
C
C̄
330
335
275
270
265
ZERO CROSS
315
310
345
285
350
355
360
340
285
+12.5V
320
X1
X2
X3
X4
X5
X6
X7
X8
X9
X10
X

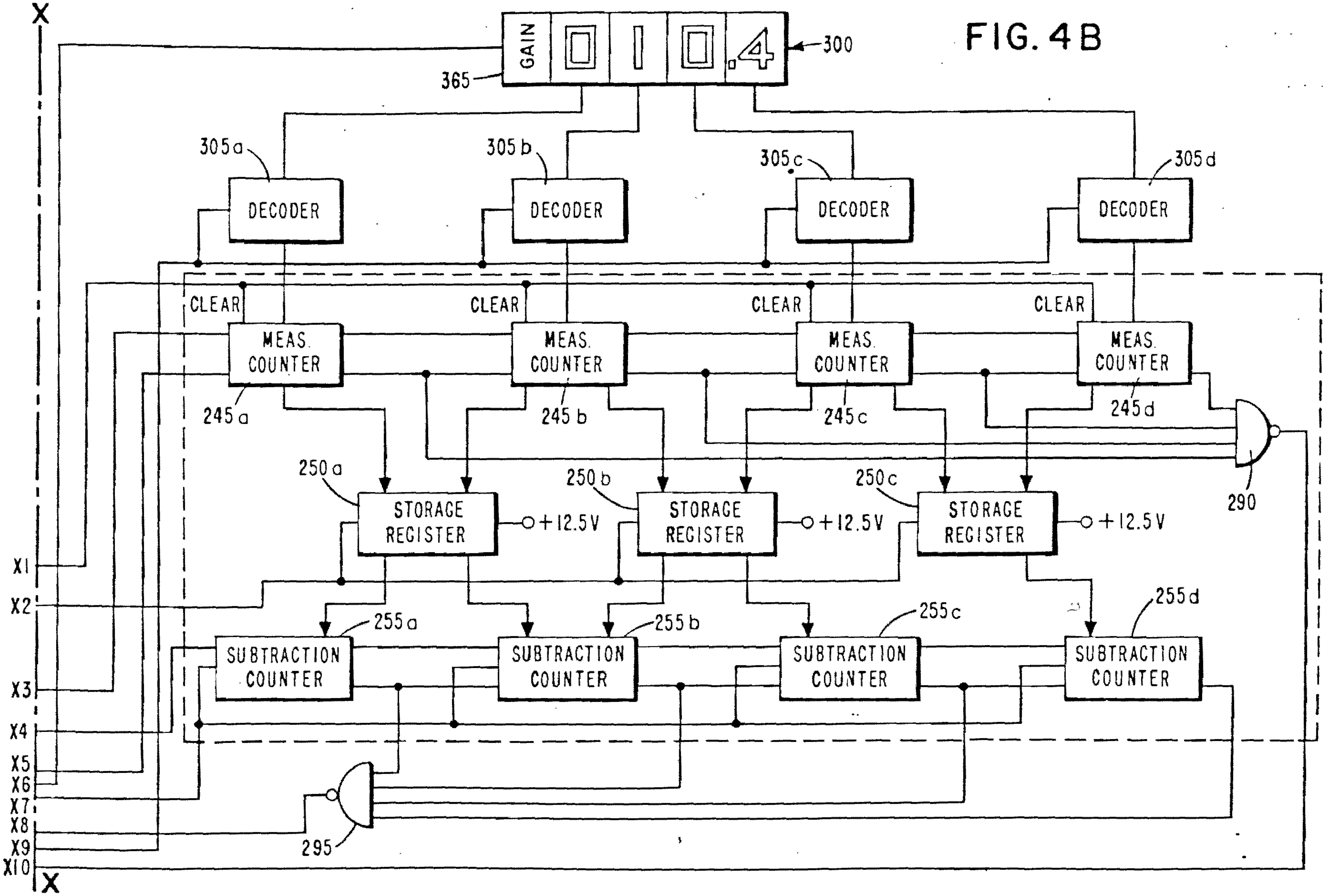
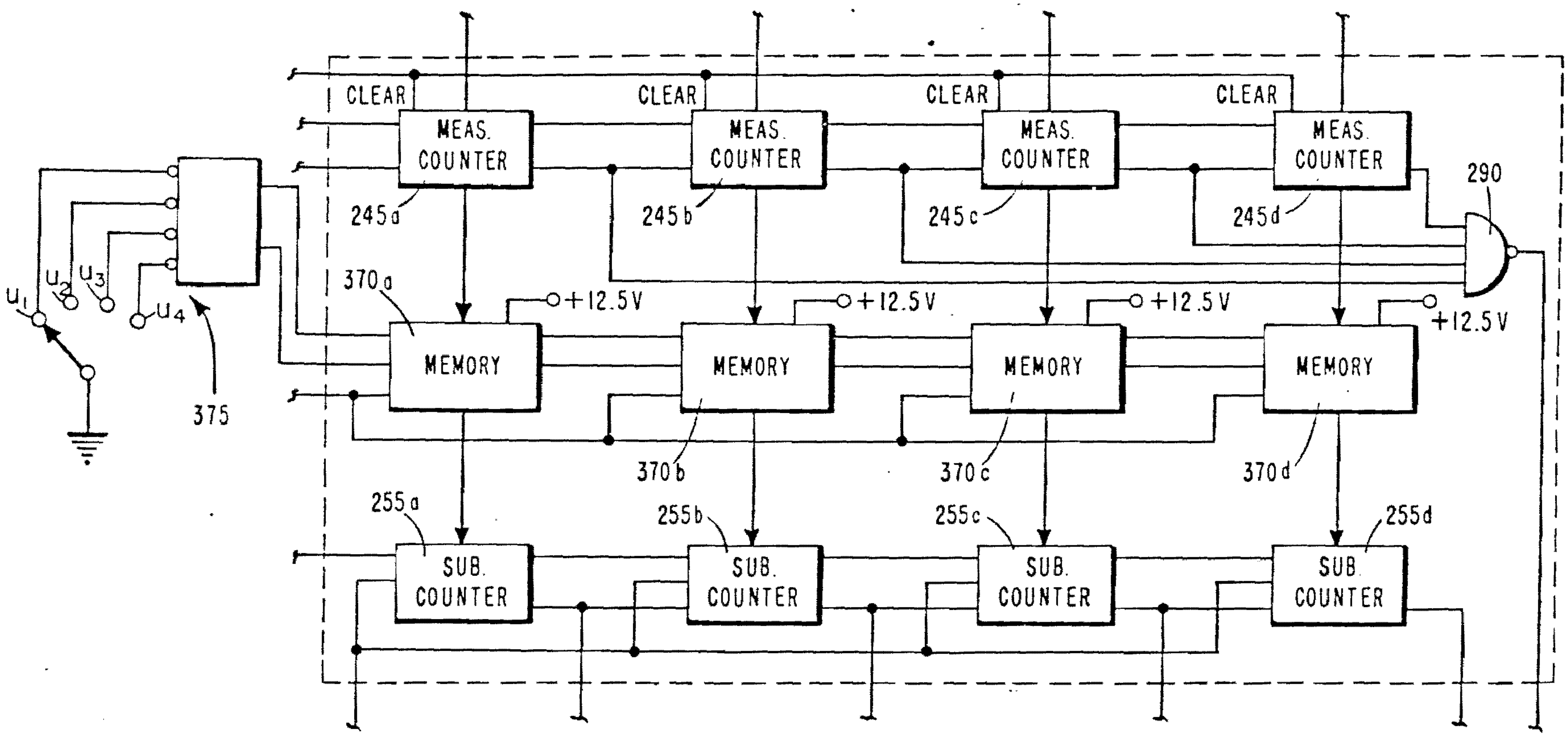

GAIN
010.4
300
365
305a
305b
305c
305d
DECODER
DECODER
DECODER
DECODER
CLEAR
CLEAR
CLEAR
CLEAR
MEAS. COUNTER
MEAS. COUNTER
MEAS. COUNTER
MEAS. COUNTER
245a
245b
245c
245d
290
250a
250b
250c
STORAGE REGISTER
STORAGE REGISTER
STORAGE REGISTER
+12.5V
+12.5V
+12.5V
255a
255b
255c
255d
SUBTRACTION COUNTER
SUBTRACTION COUNTER
SUBTRACTION COUNTER
SUBTRACTION COUNTER
295
X
X1
X2
X3
X4
X5
X6
X7
X8
X9
X10
X

FIG. 4B



CLEAR
CLEAR
CLEAR
CLEAR
MEAS. COUNTER
MEAS. COUNTER
MEAS. COUNTER
MEAS. COUNTER
245a
245b
245c
245d
290
370a
+12.5V
+12.5V
+12.5V
+12.5V
MEMORY
MEMORY
MEMORY
MEMORY
370b
370c
370d
u1
u2
u3
u4
375
255a
255b
255c
255d
SUB. COUNTER
SUB. COUNTER
SUB. COUNTER
SUB. COUNTER

FIG. 5

DIGITAL READOUT DIET SCALE

RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 445,218, now abandoned filed Feb. 25, 1974, by Michael E. Northcutt.

BACKGROUND OF THE INVENTION

Nature built into humans the capability to store food in the form of fat for hard times. In a society of over-abundant food this facility becomes a detriment and is responsible for many of the physical ills of our nation. The problem is compounded by the security and pleasure which eating gives, starting in infancy.

Present bathroom scales are very poor as an aid to weight control. They are at best only accurate to one or two pounds. Strong psychological reinforcement is required to counteract the pleasures of eating. For example, reward in the form of positive reinforcement is enjoyed by the crash dieters. To reinforce the positive aspects of weight losing the "Weight Watchers" Organization forbids the use of scales except once a week, so that progress can certainly be noted. Lacking the rigorous discipline of such a program, after dieting for several days and seeing no progress, many people experience discouragement and quit. Thus current scales, being unable to detect and indicate limited gain or loss of weight, actually act in a negative way.

The requirements of a bathroom scale providing both the requisite accuracy and designed to give the necessary psychological reinforcement are extreme. In weighing a human, a range of one to 300 or more pounds is required. If accuracy to 0.1 pound is desired this is one part in 3,000. This refinement exceeds the prior art limitation of mechanical and spring scales for bathroom use. Laboratories circumvent this magnitude of error by weighing in very limited ranges. Even physicians' scales with their extended beams do not give accuracy of the order herein envisioned.

A review of electronic scales shows consideration of tare weight, digital display, and various electronic measuring devices such as pressure transducers, wheatstone bridges, etc. However, none of these are applied to scales suitable for home use in a personal dieting program and designed for the purpose herein outlined, to provide both the required accuracy and readout format to attain the psychological reinforcement which is the aim of this unique design.

Several patents, such as Benedict U.S. Pat. No. 2,108,575, Provi et al U.S. Pat. No. 3,469,645, Hoffman U.S. Pat. No. 3,550,705 and Hutchinson et al U.S. Pat. No. 3,667,561 disclose scales suitable for home use and having electrically operated readouts. However, none has provided the capability or even recognized desirability of reading in ounces or small fractions of pounds and displaying either absolute weight relative difference between the current weight applied and a previous reference weight, as does the device described herein. Similarly, several published patents such as Rock U.S. Pat. No. 3,812,923, Smith et al U.S. Pat. No. 3,684,875 and Henderson et al U.S. Pat. No. 3,665,169 disclose apparatus in which tare weight or some other previous weight is deducted from a subsequent weight. However, none of these structures would be suitable for incorporation into any scale similar to those referenced above or that in the following disclosure. More particularly, the differential in weight discussed herein should not be confused with tare weight, since tare weight relates to containers and added or subtracted objects. Here we are dealing with weighing the same object and showing deviations with regard to time. No dialing, switching or other input is required, as would be the case with tare computations, since we are relating only to a fixed set of feedback data predetermined by formulate unique to this appliance and always relating to the same individual or small group of individuals.

The existing art demonstrates that digital readouts have been suggested for scales and that the concept of a scale suitable for home use having an electrical readout is also old. However, none of the home use scales known have sufficient accuracy to provide very accurate digital readouts to ounces or fractions of a pound over the required range, nor do they include means to indicate the relative (rather than absolute) differential between a person's previous weight and his current weight.

SUMMARY OF THE INVENTION

A personal diet scale is proposed which comprises a force voltage transducer and means responsive thereto to provide a readout not only in pounds but also in half or quarter pound increments or in ounces or in decimal equivalents to include tenths or hundredths of pounds or kilograms, or to other fractions of pounds, preferably over a range of normal human weight from zero to at least 250 pounds and preferably to 300 pounds. The scale is electronically operated by line voltage or batteries and may incorporate a digital display. A memory circuit and a circuit operable of reversing the counter to provide a readout of the relative difference between the prior weight as compared to current weight of the person desirably are provided. Further, a zero crossing circuit may be provided cooperating with the reversing and memory circuits so that the digital readout is the relative difference (gain or loss) between current and reference weights. The current invention may monitor in said manner several members of a given family simultaneously. It is simple in construction and avoids the need for manual setting of any sort with each weighing, aside from occasional zeroing of the readout as is found in any scale.

The scale herein disclosed is designed to provide a reading accurate to fractions of pounds (or kilograms) over a three hundred pound range. By utilizing such a scale a person may skip lunch and at evening weighing get positive reward and psychological encouragement to go on. The preferred embodiment displays by electronic digital display and has calculator functions to show deviation of weight since start of the diet program or the last weighing.

In a useful alternative embodiment, a switching device is provided so that several members of any family can concurrently use the differential storage and readout features of the scale. For example, a multi-color switch may be provided. Each member of the family selects a color switch and activates it at the start of his diet. From then on, no switching is required except that the individual must always have the instrument in his color mode when weighing. The diet scale may be used for addition as well as subtraction modes. This facilitates its use in charting growth in children and gain and loss of weight with precision as applied to sickness or other medically related problems. Thus, the scale has an expensive range of uses and may be provided in somewhat larger form for physicians and hospital use.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an embodiment of the digital weight comparing scale of this invention.

FIG. 2 is a detailed schematic of the embodiment of FIG. 1.

FIG. 3 is a block diagram of an alternative embodiment of the digital weight comparing scale of this invention.

FIGS. 4A and 4B together represent a detailed schematic of a third embodiment of the digital weight comparing scale of this invention.

FIG. 5 illustrates a modification to the schematic of FIG. 4B to provide for usage of the scale of the third embodiment by a plurality of individuals.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. 1 there is shown a diagram of an electronic scale which measures weight, displays the measurement, compares the value, indicates whether a loss or a gain has occurred and displays the amount of loss or gain. Means are incorporated to store a weight measurement for future reference.

Considering the block diagram of FIG. 1, to operate the scale the dieter steps on the scale platform (not shown) which closes a switch connecting a power supply to the circuitry and applies a force to the bridge type force transducer TD1 fed by a constant current source 10. The transducer may exemplarily be a PI-TRAN pressure sensitive resistor made by IC Transducers Inc. of San Jose, California. Current flowing through the bridge 5 causes a voltage difference to be developed between points A and B which is proportional to the dieter's weight. This voltage difference is amplified by differential amplifier and isolation amplifier 20 and fed to the input of the voltage controlled oscillator (VCO) 30.

The VCO 30 produces an output pulse stream of a frequency which is proportional to its input voltage (and, in turn, proportional to the dieter's weight). When the dieter steps on the scale a signal is sent from manually operable switch 60 to the counter control section comprised of delay device 63 and the timing gate generator 80. This manual two-position switch 60 can cause the counter to count up (dieter's current weight) or down (weight differential). This signal causes the delay generator to start limiting out the amount of time appropriate to allow the sensor TD1, amplifier 20 and oscillator 30 to reach a stable output (about 2 seconds) and the counter 70 to clear. At the end of this delay, timing gate generator 70 emits a gate signal of precisely controlled duration. Until this gate signal was generated, the zero output of the timer 80 held the coincidence gates 50 and 51 through which count pulses are fed to the counter 70 closed, holding the counter 70 at zero state. The timing gate 80 output is applied to the input of counter control gate 50, whose other two inputs are asserted by a manually controlled switch output and the presence of the VCO output. The output of counter gate 50 is applied to the counter's "up" clock input casing the counter to count up until the timing gate input signal from the timing device 80 is removed from the control gate 50 causing the gate to no longer pass through clock pulses to the counter. The frequency of the VCO 30 is proportional to the dieter's weight; thus the duration of the timing pulse gate is used to set in the appropriate scaling factor to accommodate various measurement systems - (e.g., English or Metric), so that the counter's readout is the appropriate digital numeral to express weight in the chosen system.

To get a display of the change in his weight since the dieter last stored a value the dieter activates the second portion b of manual switch 60, which does two things. First it sends a signal to the delay timer 63 which causes it to start timing out an appropriate delay before issuing another signal to the timing gate generator 80. The switch also disconnects the input of the VCO from the transducer and applies to this input the signal from the resistor wiper of one of the reference storage elements 40 *a, b, c* on which the dieter has stored a representation of his reference weight measurement in a manner explained below. This voltage then takes the place of the transducer - amplifier output in determining the frequency at which the VCO 30 will oscillate, the frequency being proportional to the value stored in the resistor setting (i.e., the previous weight or reference). The manual switch also provides an input to coincidence gate 51 which is the input gate to the down counter input. When this manual switch signal is present together with the timer 80 output and the pulse train from VCO 30, the paths to activate the counter 70 via this down count gate 51 are all asserted. Gate 51's output causes the down clock on the counter to be clocked until the end of the gate timing pulse, at which time the contents of the counter will indicate the dieter's present weight minus his stored weight measurement. There are three results which could be present in the counter at this time — the dieter's present weight could equal his stored weight and, as such, the counter would read zero; the dieter's present weight could exceed the previous weight and the counter would contain the difference between the present weight and the stored weight; the last alternative is that the dieter's present weight is less than the previously stored value. In this case when the counter goes through zero a signal is detected by coincidence gate 92 that also sets the negative zero crossing gate flip-flop 75 causing down gate 51 to close and stop passing count pulses to the down counter input, and opening gate 50 to start passing the VCO output pulse train to the counter up input and start counting the counter 70 back up; also, the positive feedback indicator (LOSS IND) lights; thus at the end of the gate time from timer 80 the counter 70 would display the relative difference (gain or loss) between stored reference weight value and current weight value.

The dieter is provided with a means to store his present or reference weight measurement in a resistor 40 *a, b,* or *c* by closing the set switch 40 *a, b,* or *c* coupled so that storage resistor and standing on the scale to activate the transducer output. The transducer output is compared with the voltage setting on the selected resistor by the comparator amplifier 97. The dieter manually adjusts the selected potentiometer 40 *a, b,* or *c,* until the equal indicator is lit at which time the resistor setting establishes the present or reference weight. The use of a multiple switch allows several dieters to use the same scale, each with his own stored reference weight value, the appropriate switch being closed to apply the corresponding reference to the scale.

Considering the detailed schematic diagram of FIG. 2, the transistor T1 and the several diodes and resistors in the upper left hand corner comprise a constant current source 5 to the force transducer TD1. The force transducer TD1 in the collector circuit of the transistor T1 functions in substantially the same way as a variable resistor in the collector circuit; that is, a change in the force applied to the transducer has the effect of a change in resistance in the collector circuit and therefore a change in the output current of the constant current source across resistor R11 to the input of the operational amplifier 20. Thus the output signal from the constant current source is proportional to the weight of the person being weighed.

The operational amplifier 20, which is also used to provide isolation, essentially functions to provide a conversion of the voltage proportional function which is applied to its input to a voltage value that makes the voltage controlled oscillator 30 oscillate at an appropriate frequency to represent the weight of the person applying force to the transducer. The operational amplifier may suitably be a National LM301; the voltage controlled oscillator may suitably be an EXAR 2307.

It can be seen that the output of the operational amplifier 20 is applied to one of two switchable inputs 31 and 32 of the voltage controlled oscillator 30; the other of the two switchable inputs is tied to a storage device 40 comprising a variable resistor coupled between a constant voltage source and ground, and which may be adjusted in accordance with the invention to store a signal representing the reference weight of the person which is to comprise a basis of comparison for determining the change in weight of the person being weighed, as discussed with respect to FIG. 1. Two lines come into the bottom of the operational amplifier; one of them is grounded, and the other is the control line that orders the voltage controlled oscillator 30 to respond to the voltage from the transducer 10 applied through operational amplifier 20, or the voltage stored in storage device 40. Thus means are provided for making the pulse generating voltage controlled oscillator responsive to either the current weight value of the person being weighed (as represented by the signal from operational amplifier 20) or the stored reference weight value of the person being weighed (as represented by the signal from storage device 40), whereby the difference may be determined. The output of the voltage controlled oscillator is applied to one input of both gates 50 and 51 which comprise a switch for controlling the direction of count of the up-down counter 70. The direction control gate switch 50, 51 is responsive to manually controlled switch 60 for causing counter 70 to display either the absolute weight of the person being weighed, or the relative change (positive or negative) between the current weight of the person and the stored weight of the person. The directional gate switch is also responsive to a timing device 80 which provides a gate pulse function for gating the pulses from the voltage controlled oscillator 30 to the counter 70 so that a constant duration gate for direction control switch 50, 51 is always developed, whereby the change in pulse rate or the pulse count occurring within the gate from the voltage controlled oscillator accurately represents the change in weight or the weight of the object. The counter itself comprises one or more bi-directional counters which may be a 74C192 or equivalent, the counts therein being applied through converters which may be type 4010 to display devices which may be H.P. 7302 or equivalent. The outputs of gates 50, 51 are connected to the up and down inputs of the counters to control the amount and direction of count; further description of the implementation of counter and display 70 is deemed well within the skill of the art.

Considering the manual switch 60 which controls the direction of count, the switch comprises two sets of contacts labelled "up" and "down", respectively, to thereby correspond to the desired direction of count of the counter 70. The "up" orientation of the switch and direction of count corresponds to a determination of the actual weight of the person; the "down" orientation of the switch and direction of the count corresponds to a determination of the relative change in weight between the actual weight of the person as now being applied and the reference weight previously stored in storage device 40. In operation of the scale, to obtain a readout of weight differential, the actual weight of the person is first obtained (up), then the switch activated to subtract the stored reference weight therefrom (down) thereby providing the desired readout.

Taking the first case where the "up" count to determine actual weight of the person to be weighed is desired, the output is applied to the set input of a flip-flop 75 which comprises as shown a pair of cross-coupled gates. The "up" output of flip-flop 75 thereby goes high and opens gate 50 of the directional counter control means. The "down" output of flip-flop 75 remains low, so that the voltage controlled oscillator 30 is responsive to the output of the operational amplifier 20 which is the adjusted output of the force transducer TD1, to thereby control the pulse rate output of the oscillator. Closure of the "up" switch of manual switch means 60 also applies a signal on the clear line to the clear input of timer 80 and counter 70. Thus the counter is zeroed before the output of the timer opens the gate 50 to pass the pulse count to the counter 70. The signal from the manual switch means 60, in this case the "up" switch thereof, is also passed through a NOR gate 62 and suitable delay means 63, 64 to the trigger input of the timing device 80 which generates a gate signal to control the length of time for which control gate means 50, 51 will be open. This gate is fixed at an accurate constant duration by the capacitors and trimmer resisitors shown associated with timer 80 so that the scale can be calibrated to a high degree of accuracy, and also be adjusted to read in pounds, kilos, or ounces, or halves, quarters or tenths of pounds depending on the adjustment made to the duration of the gate.

Delay means 63, 64 are interposed between NOR gate 62 and timer 80 so that the trigger signal to the timer is delayed until the counter 70 is cleared and oscillator 30 stabilized. Thus the control gate means 50 is always open for an accurately fixed length of time to pass the weight representing pulse output of the voltage controlled oscillator 30 to the digital display counter 70. The pulse frequency output of the voltage controlled oscillator, as counted during the fixed gate period, thus accurately represents the amount of the force applied to the force transducer 10. Thus the weight of the person is proportional to fixed oscillator frequency which is proportional in turn the voltage output of the transducer which is fixed by the force applied to the transducer. This system design minimizes error and provides a highly accurate and calibratable readout whereby accurate comparisons between current weight and stored reference weight may be obtained.

To obtain the change in weight between the weight now registered by the person on the counter 70 and the weight value previously stored by storage device 40, the "down" switch of switch means 60 is now closed. An appropriate input is now applied to the reset input of flip-flop 75; no signal is applied to the clear line of the counter, but a signal is again applied through the delay means 63, 64 to the timer to generate another gate function. The "up" output of the flip-flop 75 is now low, closing gate 50; the "down" output of flip-flop 75 is now high, opening gate 51 to pass pulses from the pulse output of the voltage controlled oscillator 30 which occur concurrently with the gate function from the timer 80 to the counter's "down" input. The high signal on the "down" output of flip-flop 75 which as discussed above selects the appropriate input to the voltage controlled oscillator, now causes the voltage controlled oscillator to respond to the voltage stored in storage device 40. This voltage represents the previous weight of the person being weighed; it is previously separately set into the scale using a comparison means connected between the output of transducer 10 and the storage means 40 and a separate indicator light. For example, a differential amplifier (not shown) may be connected switchably across inputs 31 and 32 having indicator connected to the output thereof; the person seeking to store a weight value on the scale to apply force to the force transducer by adjusting a manual control or the like coupled to the resistance arm of storage device 40, the status of the adjustable resistor 40 being adjusted until equality is achieved as indicated by the output of the differential amplifier between the voltage stored in storage device 40 and the voltage output of transducer 10. At this time, the current weight of the person standing on the scale is now stored in the storage device 40.

Therefore, when the signal to the voltage controlled oscillator 30 from the counter flip-flop 75 directs the flip-flop to respond to the voltage in storage device 40 through counter input 32, then the output of the voltage controlled oscillator 30 becomes proportional to this stored value. After a delay time to allow for this output pulse train to stabilize the gate function generated by the timing device 80 occurs and the counter is now counted down, the "down" counter gate 51 being open. Thus the counter is counted down by a weight proportional pulse train which is applied to the counter for the exact same time period (i.e., gate function) as the count up pulse train, whereby an accurate differential between the person's stored weight is determined.

Means are also provided for determining a zero crossing of the counter. These zero crossing means comprise a series of gates 90*a–d* coupled between the counter elements of counter 70 and feeding a control gate 92, which in turn is connected to the set input of the control flip-flop 75 as well as to an indicator light. Thus it may be seen that if each of the counter elements is counted down to zero and then the stored value is equal to or greater than the person's present weight, then a greater pulse count will occur than occurred when the person's current weight was measured. At the time zero status of each counter element of counter 70 is detected by the gate 90, the output of the gate 92 is applied to the "up" input of flip-flop 70 causing the output of the gate control 50, 51 to switch and cause the counter to begin to count back "up" so that a positive indication of weight differential is always read out on the counter display whether the differential is positive or negative. The indicator coupled to flip-flop 98 having two inputs, one from the clear signal and the other from the output of gate 92 lights to indicate that this zero crossing has occurred and, in this instance, that since the stored value is greater than the current weight value that a loss in weight has been achieved.

Thus the operational sequence for using the disclosed device is for a person who wishes to store his weight and record changes therein to stand on the scale and using the manually adjustable resistor incorporated in storage means 40 adjust the storage device until the voltage stored therein is the same as the voltage output of the operational amplifier which represents his current weight. Then, when he wishes to determine his change in weight, the person stands on the scale and pushes the "up" button, causing the counter to count up to his current weight accurately expressed in tenths of pounds or kilograms as determined by the calibration of the gate generating timer 80. Then, the "down" button is pushed causing the output of the storage device 40 to control the pulse rate output of the voltage controlled oscillator 30. The storage representing pulse train is applied to the counter through the count down gate 51, causing the counter to be counted down towards zero. If a gain in weight has occurred, no zero crossing occurs and the counter stops at a value representing accurately the gain in weight. If a loss in weight has occurred, the indicator light controlled by flip-flop 98 and control gate 92 is lit, and the flip-flop 75 is triggered to cause the counter to count back up to the value representing the loss in weight. Thus, an immediate indication in accurately expressed terms is provided of the relative gain or loss in weight achieved by the person using the digital counter scale. Of course, a plurality of persons may use the scale by providing a multi-position switch between storage means 40 and gate input 32, and providing a separate variable resistor between a constant voltage source and ground in the storage means 40, for each person using the scale (see FIG. 1). A manual selector is provided correlated with the storage to select the storage resistor storing the person's weight. No further means need be provided to store the weight of each of a group of persons. Moreover, as the same electronic elements are used to determine both the stored weight value and the current weight value an extremely accurate representation of change in weight is always provided.

In an alternative embodiment of the invention to that disclosed in FIGS. 1 and 2, a number of persons may use the scale by providing a weight storing transducer for each person, as represented by the structure of FIG. 3. In operating a scale implemented using this method, the dieter steps on the platform to which is attached the main sensor TS1 and supplementary sensor TS2 via a mechanical linkage. This type of sensor may conveniently be a transformer with a moveable core; the greater the movement of the platform-linkage combination the greater the core movement and hence the better the coupling between the primary and secondary of the transformer-sensors TS1, and TS2. The AC voltage from the generator AC1 is thus coupled across sensors TS1 and TS2 so as to produce an output voltage which is proportional to the dieter's weight. Rectifying networks 110, 112 are coupled to the sensor outputs to filter this AC voltage. This filtered voltage is coupled to the input of an operational summing amplifier 25 which provides the input to the voltage controlled oscillator 30 and represents the scaled sum of the outputs of TS1 and TS2 for reasons explained below. The oscillator's output frequency is thus proportional to the dieter's weight. When the dieter stepped on the scale a signal was sent to the control section 60 including manual control switches *60a*, *60b* to start a delay time out. After this delay the gate generator 80 produces a gate whose duration is precisely controlled. Just before this gate is produced the counter is cleared by the delay timer 63, 64. During the assertion of this timing gate, the output of the oscillator is passed to the up clock input on the counter 70. The gate's duration and the frequency of the oscillator output combine to yield the value in the counter at the end of the gate time just as in the previously described method, thus producing the measurement of the present weight of the dieter.

The method of obtaining the difference in the dieter's weight and storing a weight reading is different from the previous embodiment. The dieter stores his weight reading by setting sensor TS2's beginning point of movement; in other words, the second transducer's physical position stores the value of the dieter's weight measurement. This is accomplished by setting the second transducer's TS2 movement arm in such a way as to cause movement only after a certain portion of the travel of TS1 has been accomplished. By way of example if the dieter weighed 140 lbs. and wanted to store that value he would put the scale into the store mode be setting a switch 27 which would enable the comparator 120 to be connected to TS1 and TS2, turning an adjustment screw until the voltage output from TS2 matched the zero set voltage store on R121 at which time the equal indicator is lit. This adjustment screw would actually be moving TS2 until a "NULL" voltage occurred. From this point on then whenever the dieter depressed the Δ W switch 26 a measurement is taken relative to this setting. Since the dieter can either gain or lose weight the actual "zero" or "null" point is set ½ way through the travel of the second sensor TS2 and the control mechanism compensates for the non-zero position of the sensor by adjusting the final value in the counter by an appropriate amount. This value is obtained in the same manner as a normal measurement is taken. Amplifiers 120, 130, 140 provide the means by which the indicators are lit to feed back to the dieter his state of affairs. As mentioned earlier amplifier 120's output is used to indicate the equal condition in setting up the Δ W sensor, — it doubles as an equal (or stable) indicator in normal operation — i.e., if the dieter's weight is stable (no change) this indicator is lit when a Δ W measurement is demanded. Amplifier 130's inputs include the Δ W sensor output and the "zero" reference voltage. If the dieter has lost weight, its output is not asserted, causing the loss indicator to be lit and the amount of loss to be displayed. If he has gained weight the Δ W voltage is greater than "zero" voltage stored on R121 and the output of amplifier 130 is asserted lighting the gain indicator and extinguishing the loss indicator. The amount of weight is obtained and displayed in the same manner as the absolute and loss measurements.

One problem which is present in this mechanism which is not present in the embodiment of FIG. 1 is the possibility that the range of sensor TS2 might be exceeded by a large change in weight; sensor TS2 operates as a "fine" scale weight change device and, as such, an indicator must be included to indicate when its range has been exceeded. Sensors CA3 and CA4 provide this service by checking the Δ W voltage against the values set in resistors R4 and R5. If the range is either too low or too high the "too much change" indicator as lit, indicating the need for the dieter to readjust his scale.

In a third highly desirable embodiment of the scale of this invention (FIGS. 4A and 4B) means are provided both for storing the dieting user's weight measurement automatically, without manual adjustment of the scale, and for displaying sequentially and automatically his current weight and then any weight loss or gain since the previous measurement. This embodiment incorporates solid state memory and switching devices to effect automatically the required storage and display switching operations. In this third embodiment the analog portions, including the transducer 205, the differential amplifier and isolation amplifier 220 and the voltage controlled oscillator 230 are substantially similar to that described in detail in the embodiment of FIGS. 1 and 2, with the addition of zero offset adjustment **225**, and will not be described in detail here.

This embodiment of the diet scale incorporates, as could the other embodiments, a power turn-on circuit 210 including a switch 215 which is closed by pressure applied to the scale platform, as by a user stepping thereupon. When switch 215 is closed, Q1 is turned on, which turns on Q2. The zener diode D1 in the circuit provides a regulated voltage (+12VS) to the transducer, its associated amplifiers and the VCO. Q1 also supplies a signal (+12VS) to power the digital circuits described herebelow.

The digital circuitry of this scale is divided between FIGS. 4A and 4B for the sake of clarity afforded by a larger scale illustration. It is to be understood that the circuitry of FIGS. 4A and 4B represent one unitary embodiment of the scale, with the illustration simply divided along lines X—X with the connections numbered *x*1 – *x*10, respectively, corresponding to one another in both figures. For clarity, this circuitry will be described first with respect to its principal functional components and then in detail with respect to the sequence of operations.

In the diagram of FIG. 4A, a monostable multivibrator 235 is provided to produce a two second delay after turn-on from switch 215, to permit weight shifting and other fluctuations to settle. Such delay unit may suitably by an EXAR 4047 multivibrator or equivalent. Timer 240 is a precise measurement timer which is adjustable in the same manner and for the same reasons as in the previous embodiment. Measurement counter 245*a–d* (FIG. 4B) is an up-down counter as previously described, and may suitably comprise a plurality of 74C192 circuits. The value measured from counter 245 is stored in the storage register 250*a–c*, which may conveniently be 74C174 circuits and which are powered directly from the 12.5 volt source and not from the power switched circuit, so that, when the scale is not energized by the closing of switch 215, the value stored in register 250*a–c* will not be lost due to the loss of power. For determining weight changes there is added to this embodiment another counter 255*a–d* (which may also be 74C192's), whose purpose is to hold the value which is to be subtracted from the measurement counter and counted down.

To provide the major time periods during which certain operations, described below, take place, there is provided a control counter chain 260a, 260b, 260c (FIG. 4A), which may comprise a plurality of 74C73's. This counter chain 260*a–c* is clocked by the timer 240 output and is made to loop back on itself and oscillate by NAND gate 265, causing the counter chain to count up at the rate determined by the timer 240 oscillation frequency. The time periods determined by the counter 260a–c are decoded by NAND gates 270, 275, 280 and 285.

NAND gates 290 and 295 (FIG. 4B) decode when the measurement (up-down) counters 245 and the subtraction (down) counters 255 pass through zero respectively.

Display 300 is a seven segment liquid crystal display which is driven by a plurality of 74C48 BCD-to-7-segment decoders 305a-d connected to the measurement counters 245a–d.

Oscillator 310 is a two-inverter R-C coupled oscillator whose frequency is at least 3000 times the timer gate interval but less than the highest clock frequency of the measurement counters 245. One output of the oscillator 310 is connected to the blanking inputs of the display decoders 305a–d to provide an alternating current signal to gate the liquid crystal, to provide for best liquid crystal display operation.

With reference to the foregoing description and the diagram of FIGS. 4A and 4B the sequence of operations of the scale of this embodiment is as follows:

When a user steps on the scale, his weight applied to the platform (not shown) closes power switch 215, which in turn activates switches Q1 and Q2. The signal +12VS from the emitter of Q1 provides power to the digital circuits and a trigger input to the monostable multivibrator delay 235. The delay 235 times out for about two seconds while clearing the counter chain 260a–c, the zero cross flip-flop 315 (a74C73) and the holding-off gate 320 to prevent false triggering of storage registers 250a–c. At the end of the two second interval the D output of the delay 235 goes low, activating NOR gate 325 and starting the oscillator of the timer 240. This oscillator gates the VCO output through NAND gate 330, as the output of NAND gate 275 is asserted at this time via inverter 335. Measurement counter 245a–d is counted up for the duration of the measurement interval (the assertion time of the timer 240), thereby providing for time averaging the VCO output signal and thus the measured weight indication over the period of the measurement interval. This measurement interval, from timer 240, is selected to provide the weight measurement in the desired increments of ounces or halves, quarters, or tenths of pounds or kilos, or other units. When the timer 240 is no longer asserted, NAND gate 265 acts as a feedback gate and restarts the timer. The second edge of the timer clocks the counter chain 260a–c, causing it to count up by one. This deactivates gates 275, 335 and 330 and activates NAND gate 340, transferring the contents of the storage register 250a-c into the subtraction (down) counter 255a–d. At the next timer clock edge, NAND gate 285 is activated, copying the contents of the measurement (up-down) counter 245a-d into the storage register 250a–c thus storing the current measured weight for the next time the user uses the scale, to have it available for comparison with a subsequent measured weight.

During the next two timer cycles nothing happens except the display for a predetermined time of the current measured weight value. Then, during the following timer cycle, NAND gate 280 is activated. This step gates the output of the oscillator through to the count-down input of the measurement counter 245a–d and the subtraction counter 255a–d, simultaneously counting them down until either a zero crossing is sensed by NAND gate 290 or a zero in the subtraction counter is sensed by the NAND gate 295. If a zero crossing is sensed by gate 290, the zero crossing flip-flop 315 is jam-set by gate 290. This causes the count direction to change on the measurement counter to "up" via NAND gates 350 and 355, acting through NOR gates 352 and 357. The subtraction counter continues to count down until it is at zero, at which time the gate 295 senses this condition. If the subtraction counter is zeroed in this manner or in the manner previously described, the oscillator output is gated off by NAND gate 360, preventing further counting. At this time the difference between the previous measurement (from the storage register) and the current measurement are displayed on digital display 300. If there was a zero crossing, the user gained weight, and the indicator 365, driven by zero crossing detector 315, is lit, thus indicating a weight gain, with the amount displayed in the display 300. If the previous weight measurement is larger than the new measurement, no zero crossing is detected and the amount of loss is held in the measurement register 245a-d and thus displayed in the digital display 300. At the next clocking of the timer 240, NAND gate 270 is activated, stopping further oscillator action by the timer 240. Thus, the digital display will continue displaying the difference between the previous weight measurement and the current weight measurement until the user steps off the scale, deactivating the power switch circuitry 210.

In another variation of the scale of the immediately preceding embodiment provision may be made for storing a plurality of previous weight measurements, so that the scale may either be used by a corresponding plurality of users and in the manner above described, or an individual user may store a plurality of his previous weight measurements for later comparison against subsequent measurements. One illustrative embodiment of this variation in structure is illustrated in FIG. 5 wherein the structure enclosed within the broken line may be directly substituted for the structure enclosed within the broken line of FIG. 4B.

In the structure of FIG. 5, the measurement counter 245a–d, subtraction counter 255a–d and gate 290 are the same as in FIG. 4B, with identical connections across the broken line. However, in place of storage register 250a–c of FIG. 4B an array of 16 bit (4 × 4) memory chips 370a–d, controlled by a selector switch 375. While modification of this structure for any number of storage positions may readily be made by one skilled in the art, this illustrative embodiment, with its 4 × 4 memory chips, illustrates structure for storing 4 such weights. With this structure each of four different users may select on switch 375 his individual operating position (U1, U2, U3, or U4) and thus configure the scale and its memory storage units for storing and comparing his personal subsequent measurements with his personal previous measurements. Similarly, if desired, a single user could store a plurality (four in this case) of his individual previous weight measurements for selective comparison against his subsequent weight measurements.

While the foregoing represents several preferred embodiments of the apparatus of this invention, it is recognized that other variations and embodiments, for example, different types of transducers, displays and electronic circuit components, may occur to persons skilled in this art. Accordingly, the scope of this invention is not to be limited by the foregoing but is to be defined by the claims appended hereto.

I claim:

1. A scale for use in a personal dieting program, comprising:

weight measuring means sensitive to weight increments at least as small as ½ pound for a weight measured by said scale;

means for storing a previous measurement of weight for comparison with a subsequent measurement; and

a digital display capable of displaying both said subsequent weight measured by said scale and the difference between said subsequent weight and said previous weight measured, indicating either weight gain or loss, said digital display providing for display of said subsequent weight measurement and said weight difference in increments at least as small as ½ pound, whereby measured weight gains and losses on the order of ½ pound may be observed by the user of said scale to thereby assist his dieting program.

2. A scale as in claim 1 wherein said weight measuring means is sensitive to weight increments at least as small as ¼ pound and wherein said digital display provides for display of said subsequent weight measurement and said weight difference to increments at least as small as ¼ pound.

3. A scale as in claim 1 wherein said weight measuring means is sensitive to weight increments at least as small as 1/10 pound and wherein said digital display provides for display of said subsequent weight measurement and said weight difference to increments at least as small as 1/10 pound.

4. A scale as in claim 1 wherein said weight measuring means includes means for averaging measured weight indications over a predetermined time period during weighing, whereby fluctuations in the displayed weight due to shifting of weight location on said scale may be reduced.

5. A scale as in claim 1 further comprising means associated with said digital display for indicating whether said displayed weight difference represents an increase or a decrease from said previous weight measurement, whereby the user may readily observe any weight gain or loss between the two measurements.

6. A scale as in claim 1 wherein said storage means comprises a plurality of individually selectable storage units, whereby a plurality of different users may each select a different one of such storage units for storing his individual measurements for use in comparing his personal subsequent measurements with his personal previous measurements.

7. A scale as in claim 1 wherein said digital display includes means for displaying first said subsequent weight measured and then displaying said difference between said subsequent weight measured and said previous weight measured.

8. A scale as in claim 7 wherein said means for displaying first said subsequent weight measured and then displaying said difference includes means for holding said display of said subsequent weight measurement for a predetermined time and then automatically changing to display said difference.

9. A scale as in claim 1 further comprising means for energizing circuitry for said measuring means and said display in response to the weight of a user being applied to said scale, whereby the electrical power drain associated with such scale may be minimized when such scale is not in use.

10. A scale as in claim 9 further comprising means for maintaining energization of said storage means continuously, whereby energization of the storage means is independent of the application of the weight of a user to the scale.

11. In a scale for use by an individual in a personal dieting program and having a digital display and means for measuring and displaying both the current weight of a user and the difference between such current weight and a previous weight, the improvement comprising:

said weight measuring means being adapted for measuring weight increments at least as small as ½ pound; and

said digital display being adapted to display in ½ pound increments both the current weight of a user and the difference between said current weight and a preselected previous weight of such user, indicating either weight gain or loss, whereby measured weight gains and losses on the order of ½ pound may be observed by such user to assist his dieting program.

12. In a scale as in claim 11 the further improvement of said weight measuring means being adapted for measuring weight increments at least as small as ¼ pound and said digital display being adapted to display said current weight and said difference in ¼ pound increments.

13. In a scale as in claim 11 the further improvement of providing means for indicating on said display said current weight for a predetermined length of time and then automatically changing said display to an indication of said weight difference.

14. In a scale as in claim 11 the further improvement of providing means for selectively storing a plurality of said previous weight measurements and comparing any selected one of said stored previous weight measurements with said current weight measurement for display of said difference.

15. In a scale as in claim 14 the further improvement of providing switch means for selecting a desired one of said plurality of stored previous weight measurements, whereby a plurality of individuals may each store his own weight measurement and then compare the same with a later weight measurement.

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ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

March 7, 1977

Watson Brick and Tile Company
P. O. Box 6483
Tyler, Texas 75711

Attn: Mr. Russell B. Watson, Jr.

Subject: Monthly Progress Summary Letter For EES/GIT Research Project A-1899 For Period February 1, 1977 thru February 28, 1977

Dear Mr. Watson:

This progress report describes efforts expended through the February period. During the month of February the microprocessor circuit design was completed, hardware construction on the microprocessor was started, and the design of the total package was continued.

The microprocessor circuit will be contained on a single printed circuit board whose size is approximately 8" x 11". This board will contain the following components:

1. Microprocessor
   - Clock
   - Input-Output Interface
   - Buffers
2. Erasable Programable Read Only Memory (EPROM)
3. Random Access Memory (RAM)
4. Input Buffers
   - For switches
   - For decoder
5. Display Drivers
6. Displays

The interconnection of these components is basically standard in nature since the sequence of operations for the device is not determined by the wiring of the components, but rather by the microprocessor program. This allows changes to be made in the sequence of operation without rewiring the printed circuit board. A simplified flow diagram is attached.

The construction of the hardware, i.e., the wiring of components on the printed circuit board, has begun. Plastic sockets which will contain each of the chips to be used have been glued onto the printed circuit board and the wiring of interconnections among these chips has been started using the wire-wrap approach. When the hardware construction is completed, the development of the program to be used with the hardware will begin.

After considering a number of designs for the device, a final design has been selected which will maximize the simplicity of operation of the device and yet provide an attractive appearance. The original prototype plastic scale delivered to us when the project began is to be mounted onto the bottom half of the prototype scale with the incoder being developed at Georgia Tech. The printed circuit board fits nicely into the cavity of the plastic prototype scale and the displays, which are mounted over the end of the printed circuit, board align with the smaller cavity corresponding to the displays.

During the month of March the hardware construction of the printed circuit board will be completed and the development of the final program to be used with the microprocessor device will be started. When this programing is completed, the hardware equipment will be connected to the computer emulator to simulate the working of the device. When the program has been debugged and the system operates successfully, the program will be stored in the EPROM device, this device will be plugged into the printed circuit board, and final hardware debugging will take place. The result will be the final working prototype.

Sincerely,

[redacted]

James F. Lowrey

JFL/cp

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

March 29, 1977

Watson Brick and Tile Co.
P.O. Box 6483
Tyler,Texas 75711

Attn: Mr. Russell B. Watson, Jr.

Subject: Monthly Progress Summary Letter For
EES/GIT Research Project A-1899 For
for Period March 1, 1977 through
March 31, 1977.

Dear Mr. Watson:

This Progress Report describes efforts expended through the month of March.

During the month of March, the work on a prototype device neared completion. During this period, hardware construction of the micro-processor circuit board was completed, software design work was begun, and design of an optical encoder neared completion.

The printed circuit board, with its associated electronic "chips", has been completed. A "wire wrap" technique was used for the prototype device, although mass production manufacturing would probably use a system printed circuit board instead. The hardware circuitry has been checked out on the computer emulator located at Georgia Tech, and all processes operate normally, including the display of numbers artificially introduced into the circuitry.

The computer software design has been initiated, and software has been written for the testing of all circuitry. The final software program which will be eventually stored in the Read Only Memory, or ROM is in the design stage.

An optical encoder is in final phases of construction. The previously mentioned electrical encoder, which uses brushes and electrical contacts, was tested extensively with the hardware circuitry and found to be less reliable than is required for such a device. For this reason, a simple optical encoder was designed and is being constructed to replace the electrical encoder. Increased accuracy and very high reliability should result.

Plans for the month of April call for the completion of the prototype device. This prototype will be battery operated, and will be suitable for demonstration to potential manufacturers.

Sincerely,

[redacted]

James F. Lowery
Senior Research Engineer

JFL:cw

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

April 27, 1977

Watson Brick & Tile Co.
P. O. Box 6483
Tyler, Texas 75711

Attention: Mr. Russell B. Watson, Jr.

Subject: Monthly Progress Summary letter for EES/GIT Research Project A-1899 for the period April 1, 1977 through April 30, 1977

Dear Mr. Watson:

The initial prototype version of the digital personal scale is complete and in working order. This model has been designed using available components including the plexiglass cover you provided. It contains a 4 button system where an individuals last weight can be stored and compared to the current weight. The readout gives both the current weight and the weight differential in digital form.

The current model can be used 10-20 times with the battery system and is equipped with a charging circuit and a fail-safe system to shut off the system when the battery voltage drops. This allows the system to be recharged without damage or complete exhaustion of the batteries.

The patent application has been received from the lawyers by Ron Pearl with the assignment to your firm. This paperwork will be completed and the patent formally applied for in the next few days.

This work essentially completes the development program for the weighing scale. It now remains to be designed for production which can best be done by a manufacturer with existing manufacturing capability. We are aware you are in conversation with Texas Instruments and think they would be an excellent manufacturer. Someone of this caliber is required for production design and manufacture.

A cost analysis of the scale has been conducted. Our available components in the prototype cost us $247.00, however it is estimated that similar custom designed components could be made for about $30 in production quantities. This parts analysis is detailed in the enclosed attachment. Assembly labor is estimated at $20 resulting in a total manufacturing direct cost of $50.

This essentially completes the design work on Project A-1899 and there should be no appreciable charges after this month except for those legal fees associated with the patent. However, we are available to assist you in presentation to potential manufacturers or sales programs as you desire. We can be available for those with reasonable notice.

Relative to the fireplace project now in its formulation stages both Rick Wright and Grant Curtis attended the wood heating seminar in Cambridge, Massachusetts, and their report is attached. We will actively proceed with this project as soon as the contract is approved.

It has certainly been a pleasure to work with you and your son on this weighing scale project and we wish you the best int its sales and marketing.

Sincerely,

[redacted]

J.F. Lowry
Program Manager

JFL:lt:cw
Enclosure